Yarn Properties Testing

3rd year TED

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Chapter - one

Introduction to Textile Testing

testing ;– Is a means of determining the capability of an item to meet specified requirements by subjecting the item to a set of;.

- physical
- chemical
- environmental
- or operating actions and conditions

Objective of Testing

- ✓ Checking the quality and suitability of raw material
- ✓ Monitoring of production i.e. process control.
- ✓ Assessment of final product, whether the quality is acceptable or not, (how will be the yarn performance in weaving? etc).
- ✓ Specification testing: Specifications are formed and the materials are tested to prove whether they fall within the limits allowed in the specification (e.g. specified by a customer).
- ✓ Research development

Sampling

❖ It is not possible or desirable to test all the raw material or all the final output from a production process because of ***time and cost constraints.***

❖ Also many tests are ***destructive*** so that there would not be any material left after it had been tested.

❖ Because of this, representative samples of the material are tested.

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The amount of material that is actually tested can represent a very small proportion of the total output. It is therefore important that this small sample should be ***truly representative*** of the whole of the material.

✓ The aim of sampling is to produce an unbiased sample in which the proportions of, for instance, the different fiber lengths in the sample are the same as those in the bulk.

✓ Or, each fibre in the bale should have an equal chance of being chosen for the sample

Selection of samples ;

- The sampling methods are governed to a large extent by factors such as:
  - ✓ the form of the material
  - ✓ amount of material available
  - ✓ the nature of the test
  - ✓ type of testing instrument
  - ✓ information required
  - ✓ degree of accuracy required

Statistical terminologies used for sampling are:

Population; –consists all the subjects that to be study

e.g. batch of cotton

Sampling; –is the process of selecting a group of subjects in such a way that the individual represent the large group from which they were selected .

Sample ; -a portion of a lot of material which is taken for testing

Specimen; a specific portion of a material or laboratory sample up on which test is performed or w/c is selected for that purpose. E.g. taking 100 gms of cotton from 10 bales selected from batch of cotton.

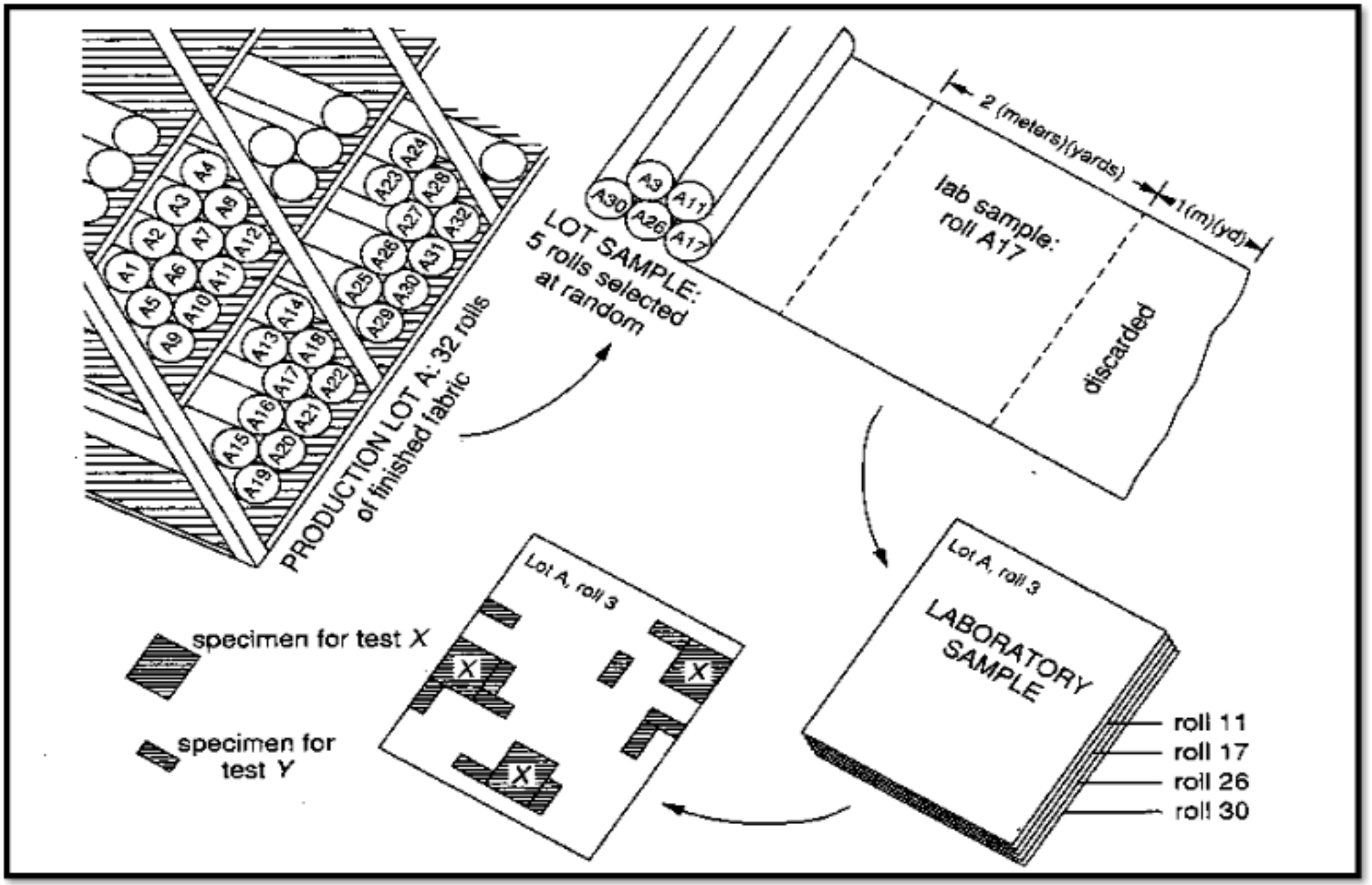

Fig : relationship among production lot ,lot sample, laboratory sample and specimens

- Materials taken from the lot sample for testing is laboratory sample

Sample Size ;

Size of population	Sampling percent
0-100	100%
101-1000	10%
1001-5000	5%
5001-10000	3%
10000+	1%

Sampling Techniques;

- The four major types of sampling techniques are;.

1. simple random sampling
2. systematic sampling
3. stratified sampling
4. cluster sampling

Simple random sampling;

- Simple random sampling basic characteristics is that all members of the population have ***equal and independent chance of being included in the sample***
- It is the most preferable method of sampling

Example 1- A garment factory manager wants to export 5000 T-shirts as per specification he got from the customer and he wants to check the conformance of his product with his customer specification after production of T- shirts . Here is how he did it:

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i. the population is 5000 (the batch of T-shirt)
ii. the desired sample size is 5% or 250 T-shirts
iii. then 250 T-shirts are randomly selected from 5000 T-shirts placed in organized way for convenience accessing individual member of population

Systematic sampling

- Systematic sampling is one in which every K^{th} subject on a list is selected for inclusion in the sample.
- The "K" refers to sampling interval, and may be 3rd (K=3) or 10th (K=10) subject.
- The value of K is determined by dividing the population size by the sample size.

Example -2 :Let say that you have 36-meters of 1000 rolls fabric. If you decided to use a sample size of 100,hence

K=1000/100=10 ,then if you choose every 10th of roll of fabric you will get a sample of 100.

Stratified Sampling(SS)

✓SS permits the tester to identify sub-groups within a population and create a sample w/c mirrors these sub-groups by randomly choosing subjects from each stratum .

✓Such a sample is more representative of the population across the sub-groups than a simple random sample would be.

✓Sub- groups in the sample can either be of ***equal size*** or ***proportional*** to the population size .

✓***Equal size sample subgroups*** are formed by random selecting the same number of subjects from each population subgroup.

✓***Proportional sub-groups*** are formed by selecting subjects so that the sub-group percentages in the population.

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Example 3: The following is a proportionally stratified sample:

- ✓ population =9000 trousers
- ✓ the desired sample size is = 3%=270
- ✓ recording and leveling all 9000 trousers and classifying 9000 trousers say:
  - 65% -medium size (M) =5850
  - 20% -small size (S) = 1800
  - 15 % -large size (L) = 1350
  - therefore 65 % of the sample = 176

    20% of the sample = 54

    15 % of the sample = 40

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- Therefore, a sample of 270(176+ 54+ 40) trousers, which is representative of the 9000 and which reflects proportionally each size category of trousers

Cluster Sampling(CS)

CS involves randomly selecting groups ,not individuals.

It is often impossible to obtain a list of individuals w/c make up target population, any intact group with similar characteristics is a cluster .

✓There are draw backs to cluster sampling :

- ❖First a sample made up of clusters may be less representative than one selected through random sampling
- ❖A 2nd draw back is that commonly used inferential statistics are not appropriate for analyzing data from a study using cluster sampling .

Examples of cluster include : Classrooms in the college , schools, hospitals and counseling centers in district.

Fiber sampling from bulk

Zoning

Zoning is a method that is used for selecting samples from raw cotton or wool or other loose fiber where the properties may vary considerably from place to place.

A handful of fibers is taken at random from each of at least 40 widely spaced places (zones) throughout the bulk of the batch and is treated as follows.



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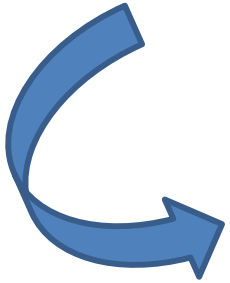

Each handful is divided into two parts and one half of it is discarded at random; the retained half is again divided into two and half of that is discarded.

This process is repeated until about n/x fibres remain in the handful (where n is the total number of fibres required in the sample and x is the number of original handfuls).

Each handful is treated in a similar manner and the fibres that remain are placed together to give a correctly sized test sample containing n fibres.

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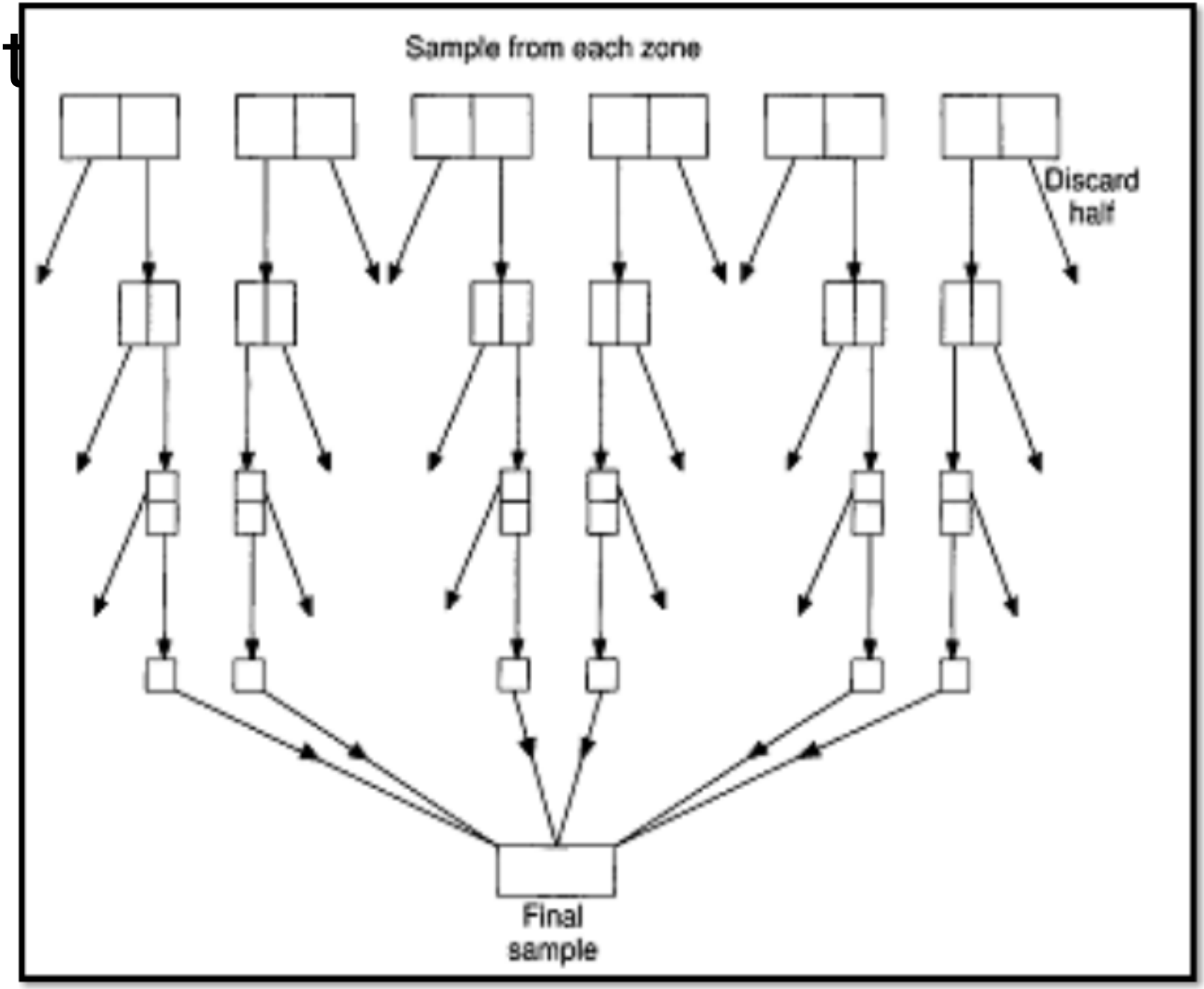

Fig...Sampling by zoning.

Atmospheric conditions for testing

Because of the important changes that occur in textile properties as the moisture content changes, it is necessary to specify the atmospheric conditions in which any testing is carried out

Therefore a standard atmosphere has been agreed for testing purposes and is defined as a relative humidity of 65% and a temperature of 20^0C.

For practical purposes certain tolerances in these values are allowed so that the testing atmosphere is RH 65% ± 2%, 20 ± 2 0C. In tropical regions a temperature of 27 ± 20C may be

Regain and moisture content

The amount of moisture in a fibre sample can be expressed as either regain or moisture content.

❖ Regain is the weight of water in a material expressed as a percentage of the oven dry weight:

$$\text{Regain} \approx \frac{100 \times W}{D}\%$$

where D is the dry weight and W is the weight of absorbed water.

❖ Moisture content is the weight of water expressed as a percentage of the total weight

$$\text{Moisture content} = \frac{100 \times W}{D + W}\%$$

Factors affecting the regain

❖ For a given fibre type the moisture content is governed by a number of factors:

1. Relative humidity: The higher the relative humidity of the atmosphere, the higher is the regain of textile material which is exposed to it.

2. Time: Material that is in equilibrium at a particular relative humidity which is then moved to an atmosphere with a different relative humidity takes a certain amount of time to reach a new equilibrium.

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3. Temperature: For practical purposes the temperature does not affect the regain of a sample.

4. Previous history. The moisture content of textile materials in equilibrium with a particular relative humidity depends on the previous history of the material.

Different fibre types absorb different amounts of moisture depending on their affinity for water as shown in Fig

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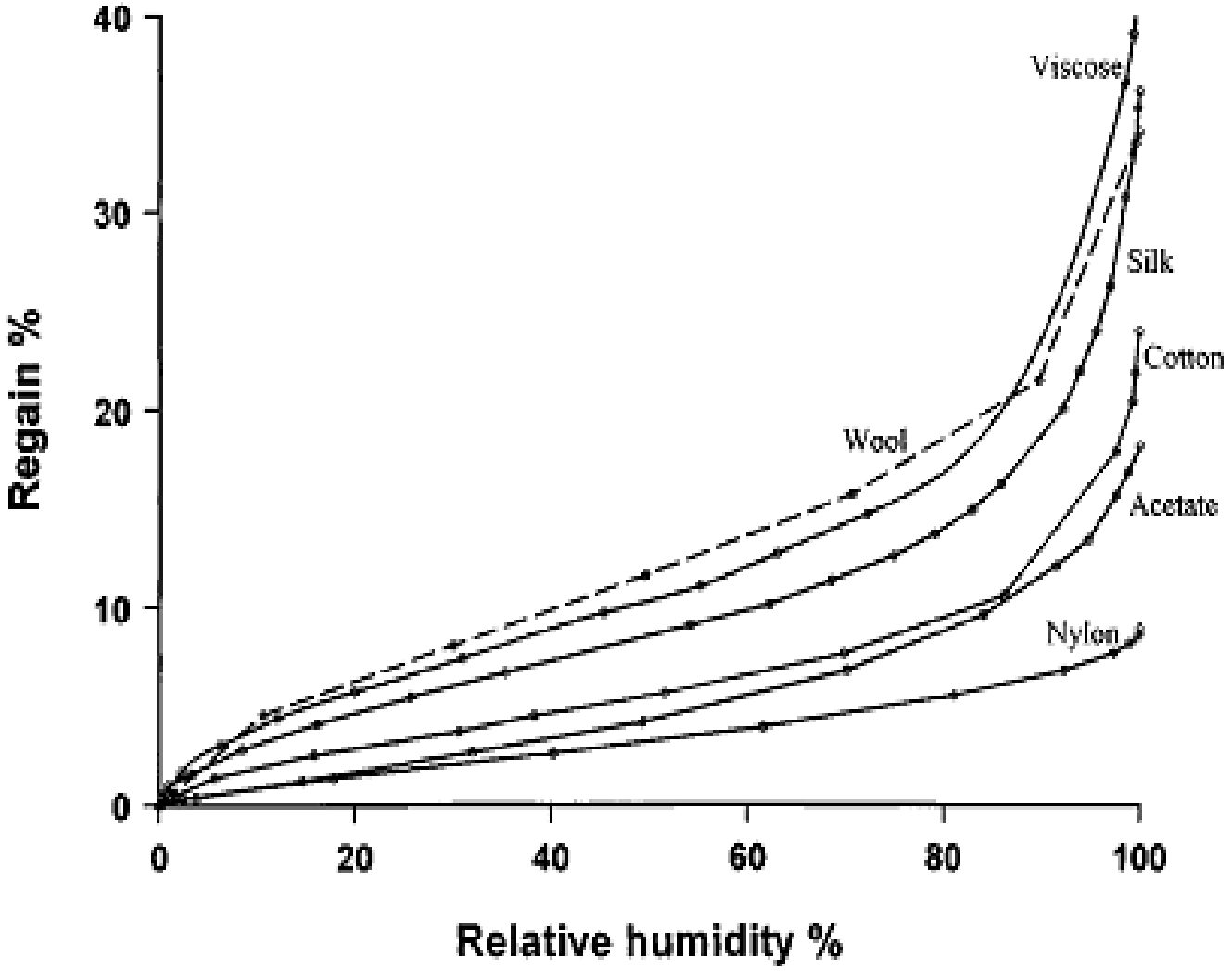

Fig...A comparison of the moisture uptake of fibres.

Methods of measuring regain

To measure the regain of a sample of textile material it is necessary to weigh the material, dry it and then weigh it again.



The difference between the masses is then the mass of water in the sample.

$$\text{Regain} = \frac{\text{mass of water} \times 100\%}{\text{oven dry mass}}$$

Cont…

❖Regain is based on the oven dry mass, which for most fibres is the constant mass obtained by drying at a temperature of 105 ± 2 0C.

❖Constant mass is achieved by drying and weighing repeatedly until successive weighings differ by less than 0.05%.

Conditioning oven:

❖ A conditioning oven, is a large oven which contains the fiber sample in a mesh container.

❖The container is suspended inside the oven from one pan of a balance, the mechanism of which is outside the oven.

❖ This ensures that the weight of the sample can be monitored without the need to remove it from the oven.

A continual flow of air at the correct relative humidity is passed through the oven which is maintained at 105 0C.

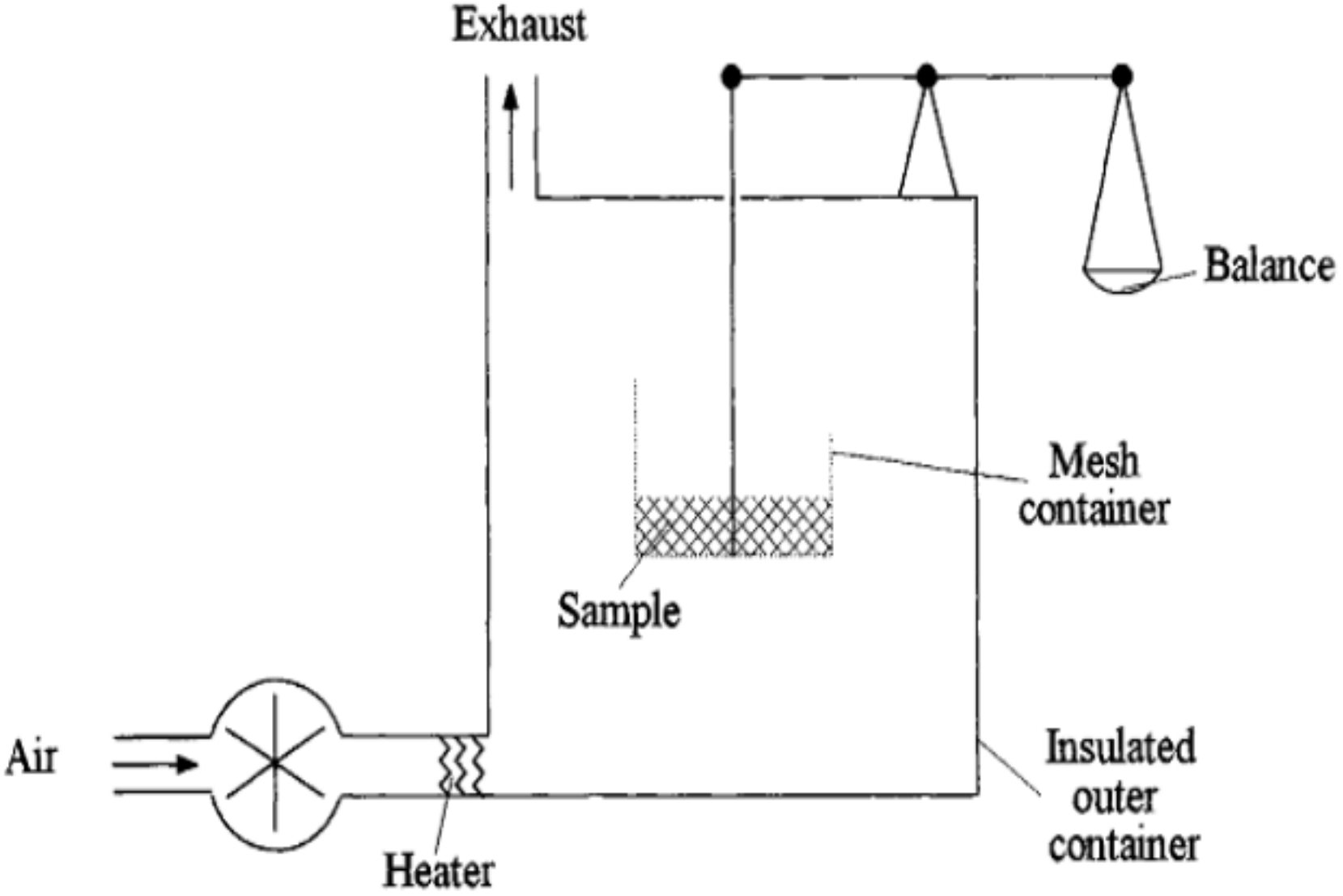

Fig...A conditioning oven.

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The main advantage of using a conditioning oven for carrying out regain determinations is that all the weighing is carried out inside the oven.



This means that the sample does not gain moisture as it is taken from the oven to the balance.

Electrical methods;

In a typical electrical resistance measuring instrument, two electrodes are pushed into a package of yarn and the resistance between the electrodes is measured by suitable electronics, the answer being displayed on a scale which is directly calibrated in regain values.

Different electrode sets are used for different packages, for example long thick prongs for bales and short needle like probes for yarn packages. The instrument usually has to be calibrated for the type of probe, the type of fibre and the expected regain range.

The great advantages that electrical methods possess over drying and weighing methods are the speed and ease of reading, the fact that they can be calibrated directly in regain units and the ease with which instruments can be made portable.

The disadvantages of electrical methods are the need to recalibrate them as they are indirect methods, the variations in readings due to packing density, the possible presence of dyes, antistatic agents and also variations in fibre quality.

Correct invoice weight

When textile materials are bought and sold by weight, it is necessary for there to be agreement between buyer and seller on the exact weight that has to be paid for. This value can vary considerably with the moisture content of the material which in turn varies with type of material, the atmospheric moisture content at the time and how wet or dry the material was before it was packed, among other factors.

The buyer certainly does not wish to pay for excess water at the same price per kilogram as the textile material. A 'correct invoice weight' is therefore determined according to.

In this procedure the consignment is considered to contain a percentage of water known as the standard regain allowance and the weight of the consignment is calculated as if it contained this amount of water.

When a consignment of textile material is delivered and weighed, a sample is taken from it on which tests are made which enable the correct invoice weight to be calculated.

Samples of at least 200g are selected according to adequate sampling procedures and immediately stored in airtight containers so that no moisture is lost. The samples are weighed and then the oven dry weight is determined as described above.

In some cases other non-textile materials, such as oils, grease, wax and size, are removed before drying.

If M , mass of consignment at time of sampling, D = oven dry mass of sample, S = original mass of sample and C = oven dry mass of the consignment:

$$C = M \times \frac{D}{S}$$

To the oven dry mass is added an official allowance for moisture depending on the nature of the material. This regain allowance, sometimes called the 'official' or 'standard' regain, is set out in BS 4784.

These values are only approximately the regains the materials would have when in equilibrium with the standard atmosphere and represent agreed commercial numbers for the purposes of determining quantities such as consignment weights, yarn counts and percentage compositions which vary with moisture content.

The regain allowances vary depending on what physical state the material is in, for example woollen yarn 17%, worsted yarn 18.25%, oil combed tops 19%, wool cloth 16%.

$$\text{Correct invoice weight} = C \times \left(\frac{100 + R_1}{100}\right)$$

where R1 = commercial moisture regain.

Table …Regain allowances.
Note that regain values depend on the form of the material

Fibre type	UK regain (%)	US regain (%)
Man-made fibres		
Acetate	(9)	6.5
Acrylic	2	1.5
Nylon 6, 6 and 6	(6.25)	4.5
Polyester	(1.5)	0.4
Polypropylene	(2)	0
Triacetate	(7)	3.5
Viscose	(13)	11
Natural fibres		
Cotton – natural yarn	8.5	7
Linen fibre	12	12
Linen yarn	12	8.75
Silk	11	11
Wool – worsted yarn	18.25	13.6
Wool – fibre clean scoured	17	13.6

If the samples are dried after cleaning a different set of allowances is used for moisture and oil content, etc:

$$\text{Correct invoice weight} = C \times \left(\frac{100 + R_2 + A_2 + B_2}{100} \right)$$

where R2 is the moisture regain which may differ from R1, A2 is the allowance for natural grease and B2 is the allowance for added oil. In most cases an overall allowance is given which includes the values for moisture and natural and added fatty matter.

In the case of a blend the overall allowance is calculated from the fraction of each component in the blend multiplied by its regain value, for example: 50/50 wool / viscose (dry percentages)

$$\frac{50 \times 17}{100} + \frac{50 \times 13}{100} = 8.5 + 6.5 = 15\%$$

Regain values vary slightly from country to country. For instance, the USA has a single value of 13.6% for wool in all its forms but has separate values for natural cotton yarn (7.0%), dyed cotton yarn (8.0%) and mercerised cotton yarn (8.5%), although there is no value laid down for raw cotton. Therefore the appropriate standard should be consulted for the correct commercial regain figures.

Reading assignment



- Electrical and capacitance methods for measuring moisture