K S RANGASAMY COLLEGE OF TECHNOLOGY

TIRUCHENGODE-637215

(Autonomous)

DEPARTMENT OF TEXTILE TECHNOLOGY

E-CONTENT

51 TT 601 - Textile and Apparel Quality Evaluation

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Lecture Notes

1. Introduction to Yarn Quality Evaluation

1.1 Definition of Quality

- **Quality** is defined as the **degree of excellence** of a product that meets customer requirements and conforms to specifications.
- In textiles, it means the **fitness for use** of a fibre, yarn, or fabric in terms of strength, appearance, uniformity, etc.

1.2 Types of Quality

1. **Quality of Design:**
    - Refers to the level at which the product is designed to meet consumer needs.
    - Includes choice of materials, yarn type, fibre blend, etc.
2. **Quality of Conformance:**
    - Degree to which the manufactured product conforms to the original design.
    - Affected by manufacturing process, equipment, and workforce skill.
3. **Quality of Performance:**
    - How well the product performs during use.
    - Includes durability, comfort, dye fastness, and appearance retention.
4. **Quality Control (QC):**
    - The process of **detecting defects** and correcting them during production.
    - Involves inspections, testing, and measurements.
5. **Quality Assurance (QA):**
    - **Systematic planning and preventive actions** to ensure quality.
    - Ensures right procedures are followed from design to final product.

1.3 Factors Influencing Quality

- **Raw material quality** (e.g., fibre length, strength)
- **Manufacturing equipment condition**
- **Process parameters** (twist, tension, speed)
- **Environmental conditions** (temperature, humidity)
- **Operator skill and training**

- **Storage and handling practices**

1.4 Reasons for Textile Quality Evaluation

- To maintain **product consistency**
- Ensure **customer satisfaction**
- Meet **export/import requirements**
- Aid in **research and development**
- Help in **problem-solving and fault detection**
- Improve **process efficiency**
- Monitor **machine performance**
- Compare **different suppliers/products**

1.5 Types of Sampling

1.5.1 Random Sampling

- Every unit/item has an equal chance of being selected.
- Ensures **unbiased representation** of the batch.

1.5.2 Biased Sampling

- Selection is **not purely by chance** (e.g., selecting from one area repeatedly).
- Can result in **misleading results**.

1.6 Sampling Methods

1.6.1 Fibre Sampling from Bulk:

- Collected using **sampling tubes** or **hand mixing**
- Ensure representation of **entire bulk material**

1.6.2 Sampling of Combed Slivers and Rovings:

- Taken at **regular intervals** during processing.
- Helps in monitoring **process consistency**.

1.6.3 Yarn Sampling:

- Randomly select **yarn packages**.
- Use wrap reel and balance to prepare skeins for testing.

1.6.4 Fabric Sampling:

- Cut samples from **centre, edges, and ends**.
- Represents the **full fabric width and length**.

1.7 Standard Testing Atmosphere

- **Defined by ISO, ASTM, BIS**:
    - Temperature: **20 ± 2 °C**
    - Relative Humidity: **65 ± 2%**
- Crucial because:
    - Fibres/yarns absorb or lose **moisture** depending on humidity.
    - Affects weight, strength, elongation, and other test results.

1.8 Testing Methods

- **Mechanical methods:** e.g., tensile strength testers
- **Optical methods:** e.g., microscope for fibre length
- **Capacitive methods:** for evenness testing
- **Gravimetric methods:** for linear density
- **Airflow methods:** for fibre fineness (micronaire)

FIBRE QUALITY EVALUATION – UNIT II

1. Fibre Length and Uniformity

- **Baer Sorter:**
    - Mechanical method for measuring staple length distribution.
    - Fibre samples are spread manually; sorted lengths are weighed and plotted.
- **Digital Fibrograph:**
    - Automated device measuring fibre length and uniformity.
    - Outputs Upper Half Mean Length (UHML), Uniformity Index (UI), and Short Fibre Content.

2. Fibre Fineness

- Indicates fibre diameter or linear density.

- Common units: micronaire value (cotton), denier (synthetics).
- Measured using airflow instruments or gravimetric analysis.

3. Fibre Strength and Elongation

- **Stelometer:**
    - Measures breaking strength and elongation of fibres.
    - Operates by clamping and applying tension until the fibre breaks.

4. High-Speed Fibre Measurement

HVI 1000:
HVI 1000 is a high volume instrument which is produced by world famous USTER Company. It is commonly known as USTER HVI 1000. It measures the most important cotton fiber properties for cotton classing purposes (and high-throughput requirements for spinning mills). It is the global reference tool for cotton classification, producing accurate and reliable results. It is founded on more than 60 years of fiber testing expertise and over 30 years of cotton classing experience worldwide.

Features of HVI 1000:

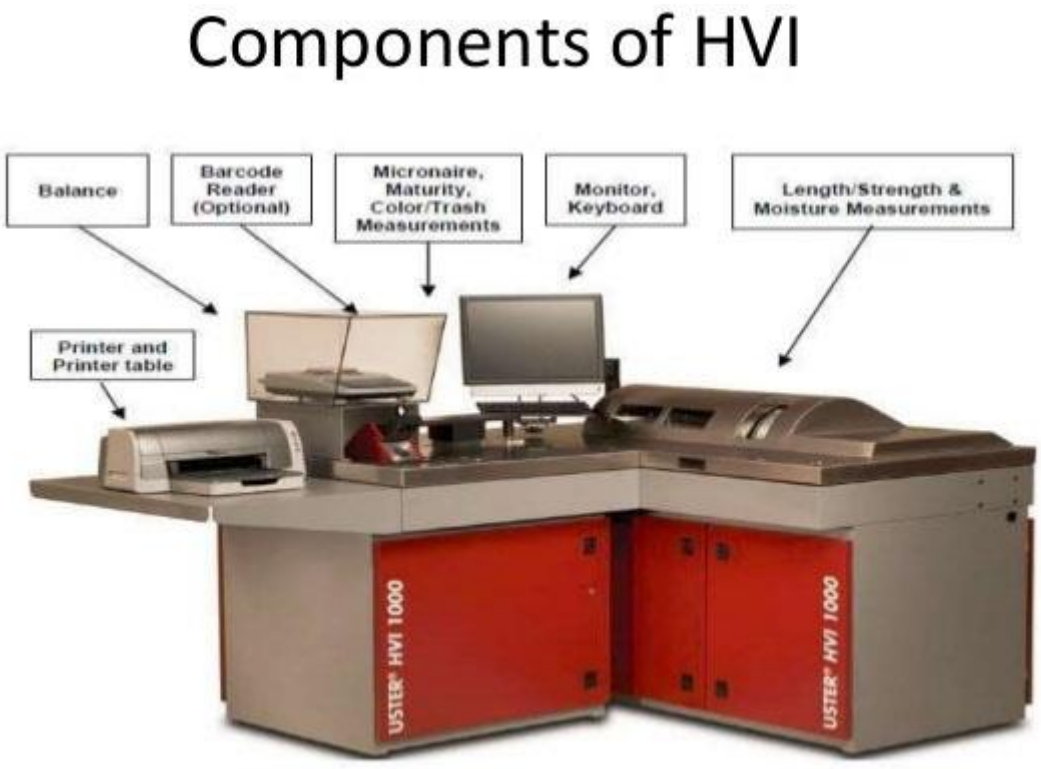
1. **It measures all the important quality parameters currently used by spinning mills such as micronaire, fiber length, length uniformity, strength, color, and trash.**
2. **Additional information on short fibers, cotton maturity and sample moisture content are also evaluated.**

3. **700 samples can be tested per 8-hour shift**

Functions of HVI 1000:
A lot of works are determined by HVI 1000. These are point out below:

- **Length,**
- **Uniformity,**
- **Short fiber index,**
- **Micronaire Value,**
- **Maturity index,**
- **Strength,**
- **Elongation,**
- **Color and trash, and**
- **Moisture content.**

Components of HVI 1000:



1. **Balance**
2. **Barcode Reader**
3. **Computer**
4. **Monitor,**

5. **Keyboard**
6. **Printer and**
7. **Printer table**

Application of USTER HVI 1000:
100% cotton samples in the form of bale or opened and cleaned material (card mat). Uster HVI 1000 is used for the measurements of the following parameters:

1. **Micronaire**
2. **Maturity Index**
3. **UHML – Upper Half Mean Length**
4. **UI – Uniformity Index**
5. **SFI – Short Fiber Index**
6. **Fiber Strength in g/Tex**
7. **Elongation**
8. **Moisture Content**
9. **Color (Reflectance Rd, Yellowness +b) & Color Grade (USDA Upland, Pima, or regional customized color chart)**
10. **Trash (% Area, Trash Count) & Trash Grade (USDA)**
11. **SCI (Spinning Consistency Index)**

A short description of each parameter is given below:

Micronaire: Micronaire Reading
Measured by relating airflow resistance to the specific surface of fibers.

Maturity: Maturity Ratio
Calculated using a sophisticated algorithm based on several HVI™ measurements.

Length: Upper Half Mean Length, Uniformity Index, Short Fiber Index
Measured optically in a tapered fiber beard which is automatically prepared, carded, and brushed.

Strength: Strength, Elongation
Strength is measured physically by clamping a fiber bundle between 2 pairs of clamps at known distance. The second pair of clamps pulls away from the first pair at a constant speed until the fiber bundle breaks. The distance it travels, extending the fiber bundle before breakage, is reported as elongation.

Moisture: Moisture Content
Moisture content of the cotton sample at the time of testing, using conductive moisture probe.

Color: Rd (Whiteness), +b (Yellowness), Color Grade
Measured optically by different color filters, converted to USDA Upland or Pima Color Grades or regional customized color chart.

Trash: Particle Count, % Surface Area Covered by Trash, Trash Code
Measured optically by utilizing a digital camera, and converted to USDA trash grades or customized regional trash standards.

- **High Volume Instrument (HVI):**
    - Measures fibre length, strength, micronaire, colour, trash content quickly.
- **Advanced Fibre Information System (AFIS):**
    - Provides individual fibre measurements including length, diameter, maturity, and neps.

- Production of quality cotton yarns is a complex task, so it's vital that test procedures, and instruments used must be accurate and reliable to have any value in today's demanding textile marketplace. Accuracy, in this context, means conformity with global standard measurements, within accepted tolerances.

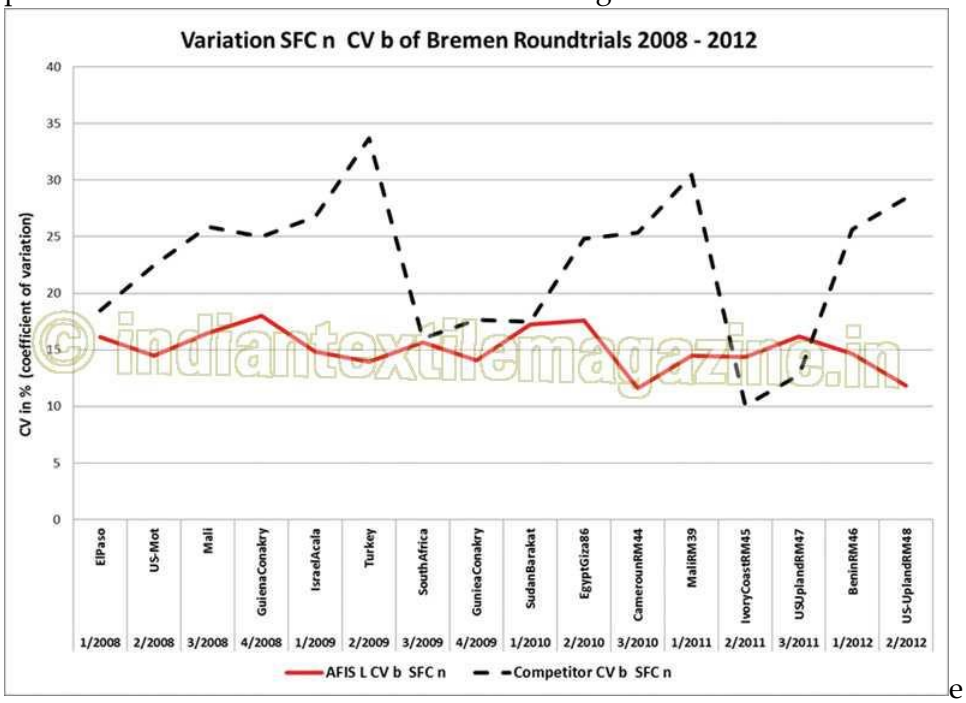
- For spinners, fiber test results influence choices about which raw material to select and how to process it. Machine settings, production rates and waste levels are all

dependent on key fiber parameters being measured and reported as accurately as possible.

- Fiber testing instruments such as the latest USTER AFIS PRO 2 are now viewed as essential tools for determining processing options, but users also need evidence that the data provided is not only accurate but also can be matched, compared and benchmarked against measurements from others with the same instrument type.

- **ICA Bremen Round Trials**

- Objective, independent analysis of test performance is the best guarantee of effective results, and the world-renowned cotton authority ICA Bremen offers a regular program of methodical sampling to fulfill this need. The ICA Bremen Round Trials are conducted three times a year, involving as many as 200 textile laboratories worldwide. Each lab tests a sub-sample of material, the master-sample being tested by ICA, to compare test results from various instrument types. The labs return their results to ICA under a code number, to preserve anonymity. The statistics are evaluated and a report circulated to the participating labs, enabling them to match their test performance against th



e general pattern.

- In this way, the Bremen Round Trials provide a regular check on the accuracy and reliability of instruments used by participants. In the case of Uster, the major instruments involved in the trials are the HVI test system for cotton fiber classification and the AFIS process optimization tool.

- The Bremen Round Trials covering the latest USTER AFIS PRO 2 instrument enable comparisons with the only major competing product in this category, the Premier

Aqura. The trials include over 50 laboratories using AFIS and about 10 using the Aqura. The AFIS can test a wider range of parameters than its competitor, so results from the trials are best compared over the two key parameters common to both instruments.

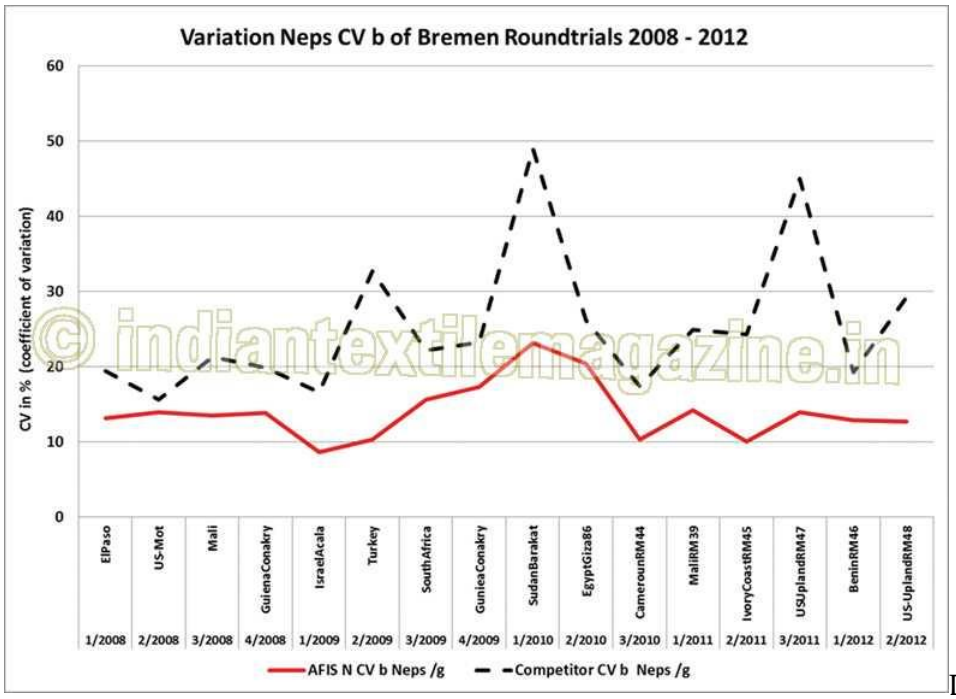
- Nep content is the first quality parameter covered in the trials. For AFIS, the results show fairly stable variations in nep measurement, at an average of about 14 per cent, while the figure for the Aqura is around 23 per cent.

- The second fiber parameter, short fiber content, again shows the AFIS with a lower level of variation, at 15 per cent, against about 22 per cent for the competitor.

- The Bremen Round Trials thus provide convincing independent evidence of the superior accuracy of the AFIS versus its competitor, underlining its capability for optimum compatibility of results between different individual instruments. The eventual benefits, in terms of yarn quality delivered to the customer and improved profitability for the spinner, are a direct result of the process specifications and benchmarking made possible by the accuracy of AFIS testing.

- **Real benefits for spinners, their customers**

- The quality of yarns depends on a multiplicity of factors, and spinners face the challenge of understanding and interpreting those factors to achieve the best quality-productivity balance. The independent tests carried out on a regular basis by ICA Bremen prove the value of AFIS as the most reliable way of helping mills get the balance right, through the most accurate fiber testing technology available.

- 

David McAlister, Product Manager, Fiber Testing, within Uster Technologies, highlights the AFIS advantages thus: “With less variation and greater accuracy over the most critical

fiber properties, AFIS has proven superiority. Mills definitely need this accuracy, to help ensure their machine settings are correct, to target the most appropriate production rates and to minimize damage to their valuable fiber raw material."

- Along with the improvements in product quality, spinners will also benefit from a reduced level of waste – another vital economic aspect for any mill – and avoid the risk of off-quality product or returns from customers.
- The Uster Group is the leading high-technology instrument manufacturer of products for quality measurement and certification for the textile industry. It provides testing and monitoring instruments, systems and services that allow optimization of quality through each individual stage of textile production. This includes raw textile fibers, such as cotton or wool, all staple fiber and filament yarns, as well as downstream services to the final finished fabric.

5. Man-Made Fibre Properties

- **Single Fibre Fineness – Vibroscope Method:**
    - Measures length and vibration frequency of a fibre under tension to determine fineness.

6. Trash and Fibre Maturity

- **Trash Content:** Measured via Shirley Trash Analyzer or HVI.
- **Fibre Maturity:** Estimated by caustic soda swelling method or AFIS.

7. Moisture Content and Regain

- **Moisture Content (%):** (Weight of water / Total weight) × 100
- **Moisture Regain (%):** (Weight of water / Oven-dry weight) × 100
- Important for accurate weight-based pricing and processing behavior.

YARN QUALITY EVALUATION – UNIT III

1. Linear Density

- **Direct System:** Tex, Denier; Mass per unit length.
- **Indirect System:** Cotton count (Ne); Length per unit mass.
- Determined using wrap reel, balance, or skein method.

2. Twist in Yarn

- **Single Yarn:** Impacts strength, appearance.
- **Ply Yarn:** Additional twist in combined yarns.
- Methods: Twist-untwist, direct count under microscope.

3. Crimp

- Describes waviness in yarn/fibre.
- Crimp% = ((Straightened length - Original length) / Original length) × 100

4. Evenness

- **Capacitance Method:** Uster Tester; measures mass variation.
- **Spectrogram:** Identifies periodic faults.
- **Variance-Length Curve:** Displays variation across length scales.

5. Yarn Hairiness

- Measures protruding fibres using Uster or Zweigle testers.
- Affects fabric surface, pilling, and dye uptake.

6. Tensile Testing

- **Principles:** Stretch yarn to break, measure force and elongation.
- **High-Speed Testing:** Simulates real processing speeds.
- **Influencing Factors:** Humidity, twist, fibre type, test speed.

7. Yarn Faults

- **Classimat System:** Classifies faults by length and thickness.
- Used for quality control in spinning.

8. Yarn Appearance Assessment

- **ASTM Yarn Grades:** Visual comparison against standard boards.
- Grades I to V based on neps, slubs, thin/thick places.

FABRIC QUALITY EVALUATION – UNIT IV

1. Tensile and Tear Strength

- **Tensile Strength:** Measured by strip or grab test.
- **Tear Strength:** Elmendorf or tongue tear tester used.

2. Bursting Strength

- Measures multidirectional strength using diaphragm or ball burst method.

3. Dimensional Stability

- Evaluates shrinkage/growth after washing.
- Measured in % change in dimensions.

4. Air Permeability

- Measures air flow through fabric under fixed pressure (e.g., Gurley or Frazier apparatus).

5. Water Vapour Permeability

- Indicates fabric breathability.
- Measured using cup method or sweating guarded hot plate.

6. Water Repellency

- Spray test and drop test measure resistance to wetting.

7. Thermal Conductivity

- Measures heat transfer capability.
- Important for comfort in apparel and technical textiles.

8. Abrasion Resistance

- Measured by Martindale or Taber abrader.
- Indicates durability against surface wear.

9. Snagging

- Measured by Mace Snag Tester.
- Important for knitted fabrics and synthetics.

10. Pilling

- Martindale or ICI pilling box used.
- Evaluates formation of fibre balls on surface.

11. Crease Recovery

- Crease recovery angle measured.
- Indicates wrinkle resistance.

12. Drape

- Drape coefficient calculated using drape meter.

- Reflects fabric's aesthetic fall.

13. Stiffness

- Measured by cantilever method.
- Indicates resistance to bending.

14. Fabric Weight and Thickness

- Weight: g/m² using GSM cutter.
- Thickness: Measured under standard pressure using thickness gauge.

15. Colour Fastness

- Tested for washing, rubbing, perspiration, light.
- Evaluated using grey scale.

16. Flammability

- Vertical and horizontal flame tests.
- Essential for children's and industrial textiles.

FABRIC ASSESSMENT FOR APPAREL – UNIT V

1. Comfort – Fabric Handle Evaluation

- **Subjective Evaluation:** Based on human perception – softness, smoothness, flexibility.
- **Objective Evaluation Systems:**
    - **KES (Kawabata Evaluation System):** Measures mechanical properties – shear, bending, tensile, compression.
    - **FAST (Fabric Assurance by Simple Testing):** Tests low-stress mechanical properties for tailoring performance.
    - **FTT (Fabric Touch Tester):** Measures physical sensations like coolness, smoothness, and softness.

2. Fabric Checking Procedures

- **4 Point System:**
    - Penalties assigned based on defect length.
    - Total points per 100 yards assessed; acceptable if within limit.
- **10 Point System:**

    - Older system, assigns 1–10 points per defect.
    - Defects graded cumulatively.
- **Fabric Inspection Machine:**
    - Mechanized setup with illumination for rolling and inspecting fabrics.
    - Records defects and helps in quality control.

3. Seam Slippage and Strength Testing

- Seam slippage: Measured by applying force along seam line and measuring fabric movement.
- Seam strength: Tensile test on stitched specimens to determine breaking load.

4. Button and Zipper Strength Testing

- **Button Pull Strength Test:** Measures the force required to pull off a button.
- **Button Impact Test:** Assesses durability of buttons to sudden impact.
- **Zipper Strength Test:** Measures tensile and crosswise strength; evaluates failure point.

5. Testing for Harmful Substances

- Conducted as per **OEKO-TEX®**, **REACH**, and other safety standards.
- Tests for:
    - Formaldehyde
    - Heavy metals
    - Azo dyes
    - Allergens and pesticides
- Ensures apparel safety for consumers and environmental compliance.