Quality Control in Yarn Manufacturing

QA Steps in Spinning

i. Setting of Norms
ii. Quality of incoming raw material
iii. Process Monitoring and Control
iv. Inspection of final product

Critical difference (CD)

Critical difference is a measure of the difference between **two values** that occur due to **normal or unavoidable** causes.

When the difference between two **values exceed** that of the critical difference, the two values are said to be **statistically different**.

$$(New)CD\% = CD\%\ (Table) \times \frac{\sqrt{N1}}{\sqrt{N2}}$$

Here, N1=Number of tests recommended in the table
N2= Number of tests actually conducted

Critical differences depend on:

i) CV%
ii) No. of Tests

Table-1: No. of test and critical difference (%) for **various fibre properties**:

Fibre Property	**No. of tests**	**CD (%)**
2.5% span length	4 combs/sample	4
Uniformity ratio	4 combs/sample	5
Microniare value	4 plugs/sample	6
Fibre strength	10 breaks/sample	5
Trash content	8 test/sample	7

Table-2: No. of test and critical difference (%) for **various yarn properties**:

Yarn Property	**No. of tests**	**CD (%)**
Lea count	40	2
Strength	40	4
Single yarn strength	100	2.8
Evenness	5	2.8

Problem-1. A mill wanted to purchase a cotton of 3.7 microns value to spin 50s count. The sample cotton received from a party was tested for micronaire and it was found to be 3.9 (on the basis of 4 test).The mill is interested to know that whether the sample cotton conforms the mills requirements.

Solution:

Difference in micronaire values=3.9-3.7=0.2

Difference expressed as a percentage of the specific value (0.2x100)/3.7= 5.4%

Critical difference (C.D) for micronaire value as in table =6%

Since the actual difference of 5.4% is lower than the CD of 6, the mills could purchase cotton from whom they received the sample cotton.

Problem-2. Mill C received 5 cotton samples from A & B. Their strength value were found to be 22 g/tex and 24 g/tex respectively (based on 5 tests). Which decision was taken by the mill?

Solution:
The difference in strength between the two cotton (gm/tex)
=24-22=2
Average of the strength value of the two cotton= $\frac{22+24}{2}=23$

Difference expressed as % of the average of the strength values $=\frac{2}{23}\times 100=8.7\%$

The CD for strength is 5% based on 10 tests. But in this case, only 5 tests were carried out to assess fiber strength. Therefore, the new CD using formula-

New CD= $5\times\frac{\sqrt{10}}{\sqrt{5}}=7.1$

Since the actual difference of 8.7% is higher than the critical difference of 7.1%, the two samples could be considered as different with regard to their strength value.

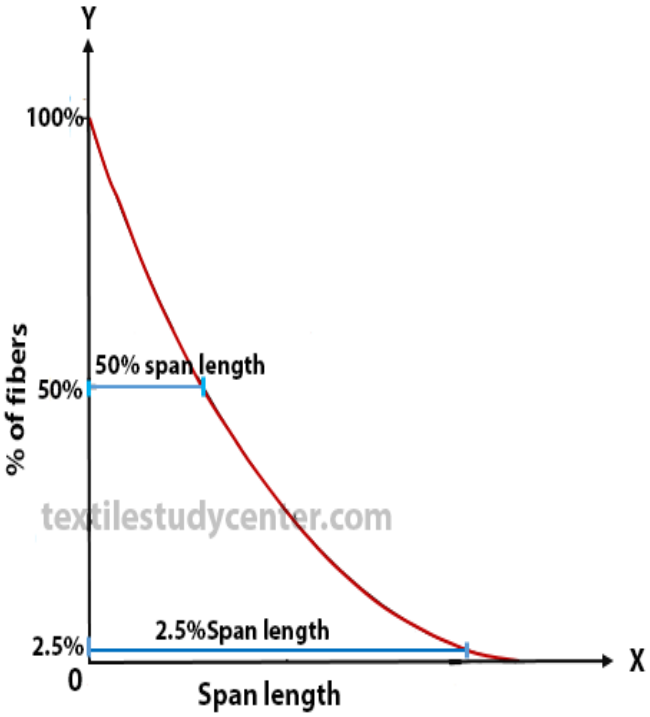
Quality of Fiber: Staple Length

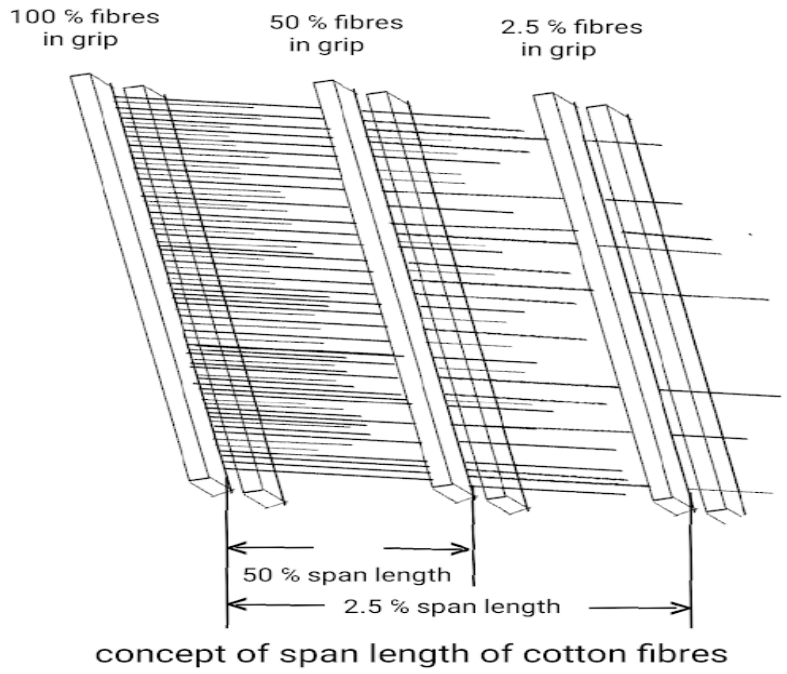
Staple Length: The average length of a spinnable fiber is called **Staple Length**. **Staple length** is also most important fiber characteristics.

Rating on staple length

Class	***Spun Length (mm)***
Extra long staple	**33.0 and above**
Long staple	**29.5 to 32.5**
Medium staple	**25.0 to 29.0**
Short staple A	**20.5 to 24.5**
Short staple B	**20.0 and below**

Quality of Fiber: Digital fibrograph





concept of span length of cotton fibres

2.5% spun length:

The fibers of a representative sample are made parallel to each other. They are straightened up to the optimum level. The fibres in the specimen are distributed randomly. The initial scanning point is assumed as 100 % fibres. Now the scanning is conducted at a place where only 2.5 % fibres of the whole representative sample are present. Now the distance between the initial point (100 % fibres) and 2.5 % fibres are recorded. This distance is termed as the 2.5 % span length of the fibres.

50% spun length:

The fibres of a representative sample are made parallel to each other. They are straightened up to the optimum level. The fibres in the specimen are distributed randomly. The initial scanning point is assumed as 100 % fibres. Now the scanning is conducted at a place where only 50 % fibres of the whole representative sample are present. Now the distance between the initial scanning point (100 % fibres) and 50 % fibres are recorded. This distance is termed as 50 % span length of the fibres.

Uniformity Ratio:

Uniformity ratio is defined as the ratio of 50% spun length to the 2.5% spun length expressed as a percentage

$$UR = \frac{\text{50\% spun length}}{\text{2.5\% spun length}} \times 100$$

This ratio is a measure of the length variability of the cotton.

Uniformity Ratio	**Grade**
47	Good
45	Average
43	Poor

Fiber Fineness:

MIC: fiber weight in micrograms per inch. It indicates the maturity and fineness of fibers

MIC	***Description***
Upto 3.1	**Very fine**
3.1-3.9	**Fine**
4.0-4.9	**Medium**
5.0-5.9	**Slightly Coarse**
6.0-above	**Coarse**

Fiber Strength:

Fiber strength is measured by breaking the fibers held between clamp jaws. It's reported as **grams per tex**, which is the force in grams required to break a bundle of

fibers one tex unit in size. A tex unit is equal to the weight in grams of 1000 meters of fiber.

Strength (g/tex)	Description
Less than 21	Very weak
22-24	Weak
25-27	Medium
28-30	Strong
31-higher	Very strong

Maturity coefficient (Mc)

The fiber maturity count is denoted by the percentages of the mature, half mature and immature fibers in a sample. It can be calculated using the formula,

$$Mc = (N + 0.6H + 0.4I)/100$$

where N - percentage of mature fibers.

H - Percentage half mature fibers

I - Percentage of immature fibers

For the chosen standard, N = 67% D or I = 7% and H = 26%.

So, $Mc = (67 + 0.6(26) + 0.4(7))/100 = 0.854$

Maturity Coefficient	Rating
Below 0.60	Very Immature
0.60 to 0.70	Immature
0.71 to 0.80	Average Maturity
0.81-0.85	Good Maturity

Fiber Quality Index (FQI)

Different fiber characteristics are synthesized into a single index called **Fiber quality index (FQI).**

FQI = (L * U *S) / F

Where, L= 50% spun length in mm

S= Fiber bundle strength expressed in gm/tex

F= fiber fineness (micronaire value)

U= Uniformity Ratio

- Properties of a cotton is as follow

  50% Span length = 28 mm

  Uniformity Ratio = 0.47

  Micronaire value = 4.3

  Strength (gm/tex) = 22.5

- Find out the FQI of that cotton

$$FQI = \frac{L*U*S}{F} = \frac{28*0.47*22.5}{4.3} = 296.1/4.3 = 68.86$$

Yarn Faults

The undesirable and sometimes unavoidable defects that are found in yarn are known as yarn fault. It is impossible to produce fault-free yarn. So, the spinners try to produce yarn with considerable limit of fault.

Faults found in yarn are:

- Count variation
- Unevenness & irregularity

- ▶ Thick thin place and neps
- ▶ Hairiness
- ▶ Lot mixing
- ▶ Dead Fiber

Causes of thick & thin places:

- ✓ Short fiber content
- ✓ Improper draft
- ✓ Poor efficiency of carding & combing
- ✓ Twist variation

Causes of Neps:

- ✓ Immature fiber
- ✓ Improper ginning
- ✓ Improper carding speed & card setting
- ✓ Less efficiency of card
- ✓ Improper drafting speed

Fiber testing equipment

HVI (High Volume Instrument):

For fineness, color, trash, length & strength measurement.

AFIS (Advanced Fiber Information System):

Sample weight taken for this test is 5 gm. Then this sample cotton is rolled up to 31 cm then it is inserted to the machine.

Shirley Analyzer:

For trash content measurement.

In this testing the trash content (seeds, particles, leaves etc.) in the fiber is measured.

Neps counter: For fiber length, neps, short fiber measurement.

Moisture Regain tester: For MR% testing.

Lap, Sliver & Roving testing equipment

- Lap length counter.
- Balance, Scale, Wrap block: For testing sliver & roving.
- Nep counting board.
- Auto sorter: For sliver count testing.
- Evenness tester.

Yarn testing equipment

- Wrap reel and balance: Yarn count testing
- Auto sorter: For count & CV% analysis
- Evenness tester: Yarn imperfection, U%, hairiness etc.
- Uster classimate: Yarn fault analysis.
- Yarn tension meter
- Twist tester
- Yarn strength tester

Software:

- Bale Inventory and Analysis Software (BIAS): For bale management
- CDS: For Automatic count measuring