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MIXING

MIXING(COTTON)

Cotton is a hygroscopic material, hence it easily adapts to the atmospheric airconditions. Air temperature inside the mixing and blow room area should be more than 25 degree centigrade and the relative humidity (RH%) should be around 45 to 60 %, because high moisture in the fibre leads to poor cleaning and dryness in the fibre leads to fibre damages which ultimately reduces the spin ability of cotton.

Cotton is a natural fibre. The following properties vary very much between bales (between fibres) fibre micronaire fibre length fibre strength fibre color fibre maturity Out of these, fibre micronaire, color, maturity and the origin of growth results in dye absorption variation.
There fore it is a good practice to check the maturity, color and micronaire of all the bales and to
maintain the following to avoid dye pick up variation and barre in the finished fabric.

BALE MANAGEMENT:

In a particular lot

- Micronaire range of the cotton bales used should be same for all the mixings of a lot
- Micronaire average of the cotton bales used should be same for all the mixings of a lot
- Range of color of cotton bales used should be same for all the mixings of a lot
- Average of color of cotton bales used should be same for all the mixings of a lot
- Range of maturity coefficient of cotton bales used should be same for all mixings of a lot
- Average of maturity coefficient of cotton bales used should be same for all mixings of a lot

Please note, in practice people do not consider maturity coefficient since Micronaire variation and
maturity variation are related to each other for particular cotton.

It the cotton received is from different ginners, it is better to maintain the percentage of cotton from different ginners thought the lot, even though the type of cotton is same.

It is not advisable to mix the yarn made of out of two different shipments of same cotton. For example, the first shipment of West African cotton is in January and the second shipment is in March, it is not advisable to mix the yarn made out of these two different shipments. If there is no shade variation after dyeing, then it can be mixed.

According to me, stack mixing is the best way of doing the mixing compared to using automatic bale openers which picks up the material from 40 to 70 bales depending on the length of
the machine and bale size, provided stack mixing is done perfectly. Improper stack mixing will lead to BARRE or SHADE VARIATION problem. Stack mixing with Bale opener takes care of short term blending and two mixers in series takes care of long term blending.

why?

- Tuft sizes can be as low as 10 grams and it is the best way of opening the material(nep creation will be less, care has to be taken to reduce recycling in the inclined lattice)
- Contaminations can be removed before mixing is made

- The raw material gets acclimatized to the required temp and R.H.%, since it is allowed to stay in the room for more than 24 hours and the fibre is opened , the fibre gets conditioned well.

Disadvantages:

- More labor is required
- More space is required
- Mixing may not be 100% homogeneous (can be overcome by installing double mixers)

If automatic bale opening machine is used the bales should be arranged as follows

let us assume that there are five different micronaires and five different colors in the mixing,
50 bales are used in the mxing. 5 to 10 groups should be made by grouping the bales in a mixing so that each group will have average micronaire and average color as that of the overall mixing. The
position of a bale for micronaire and color should be fixed for the group and it should repeat in the
same order for all the groups

It is always advisable to use a mixing with very low Micronaire range. Preferably .6 to 1.0. Because

- It is easy to optimise the process parameters in blow room and cards
- drafting faults will be less
- dyed cloth appearance will be better because of uniform dye pickup etc

It is advisable to use single cotton in a mixing , provided the length, strength micronaire ,
maturity coefficient and trash content of the cotton will be suitable for producing the required counts. Automatic bale opener is a must if more than two cottons are used in the mixing, to avoid BARRE or SHADE VARIATION problem.

It is better to avoid using the following cottons

- cottons with inseparable trash (very small size), even though the trash % is less
- sticky cotton (with honey dew or sugar)
- cotton with low maturity co-efficient

Stickiness of cotton consists of two major causes. Honeydew from Whiteflies and aphids and high level of natural plant sugars. The problems with the randomly distributed honey dew contamination often results in costly proudction interruptions and requires immediate action often as severe as discontinuing the use of contaminated cottons.An effective way to control cotton stickiness in processing is to blend sticky and non-sticky cotton. Sticky cotton percentage should be less than 25%

PROCESS PARAMETER IN SPINNING

INTRODUCTION:

Ringframe Technology is a simple and old technology, but the production and quality requirements at the present scenario puts in a lot of pressure on the Technologist to select the optimum process parameters
and machine parameters, so that a good quality yarn can be produced at a lower manufacturing cost.

Following are the points to be considered in a ringframe.

- Draft distribution and settings
- Ring and travellers
- spindle speed
- Twist
- lift of the machine
- creel type
- feed material
- length of the machine
- type of drive, above all
- Raw material chracteristic plays a major role in selecting the above said process parameters

Technical information and guidelines are given below based on the learnings from personal experience and discussions with Technologists. This could be used as a guideline and can be implemented
based on the trials taken at site. Some of this information can be disproved in some other applications, because many of the parameters are affected by so many variables. A same machine or rawmaterial cannot
perform in the same way in two different factories. This is because of the fact that no two factories can be identical.

DRAFTING:

The break draft should depend upon the following,

- fibre type
- fibre length

- roving T.M
- main draft

Some examples are given below,

Normally 1.13 to 1.18 break draft is used for

- 100%cotton , Poly/cotton blend, 100% synthetic
- roving T.M. upto 1.3 for cotton and .80 for Poly/cotton blend, 0.5 to0.7 for synthetic
- ring frame back zone setting of 60mm for fibres upto 44mm and 70mm for fibres upto 51mm
- total draft in ringframe upto 35

1.24 to 1.4 break draft is used for

- 100%cottton, poly/cotton blend, 100%synthetic fibre
- strongly twisted roving i.e higher than the above mentioned T.M.s
- total draft from 33 to 45
- back zone setting(R.F) around 52mm for fibres upto 44mm and 60mm for fibres upto 51mm

If the total draft is more than 45 or the fibre length is more than 51 and the fibre is a fine fibre(i.e more number of fibres in the cross section)with a very high interfibre friction, break draft more than 1.4 is used.

Please note that for most of the application, lower break draft with wider setting is used. With higher break
drafts, roller setting becomes very critical. Higher the break draft, higher the chances for thin places i.e. H1 classimat faults.

Higher draft with improper back zone setting will lead to thin places and hence more end breaks even though more twist flows into the thin yarn.

MAIN DRAFT ZONE:

Mostly for cotton fibres, short cradles are used in the top arm. Front zone setting is around 42.5 mm to 44 mm depending upon the type of drafting system. The distance between the front top roller and top apron should be around 0.5to 0.7mm when correct size top roller is used. This is normally taken care
of by the machinery manufcturer. If a technician changes this setting, this will surely result in more imperfections, especially with karded count the impact will be more. Therefore when processing cotton fibres, care should be taken that the front zone setting should be according to the machinery manufacturers recommendation.

For synthetic fibres upto 44 mm , it is better to use short cradles. Even with 42.5 mm bottom roller setting, 44 mm fibre works well without any problem. Because, the clamping distance will be around 52 mm or 50 mm. The imperfections and U% achieved with short cradle is better than with medium cradle(52mm setting).

Instead of using medium cradle for processing 44mm synthetic fibre, it is always better to use short cradle with 1 or 2mm wider setting than the recommended to avoid bottom apron damages.
If a mill has got a problem of bottom roller lapping, the apron damages are extremely high, it is better to use short cradle for 44 mm fibre and widen the setting by 1 or 2mm. This will minimise the complaints
and improve the basic yarn quality also.

Please note that if the bottom apron breakages are high, then the mill is working with a lot of bottom apron which is defective and with a lot of top roller which is defective. Both the defective parts produces a defective yarn, which can not rejected by older version of yarn clearers, and improperly
set new type of clearers. This yarn will very badly affect the fabric appearance.

Therefore it is always advisable to use a wider front zone setting upto 2mm , if the mill faces a problem
of excessive bottom roller lappings. Please note that the defective bottom apron and top roll will not only
affect the quality, but also the production, because the defective bottom apron and top roll make the spindle a sick spindle which will be prone to end breaks. A wider front zone setting will increase the imperfection and uster, but there will not be major deviations of yarn quality.

Nose bar height setting is very important. Depending upon the design, it is 0.7mm or .9 mm. Variation in
heigh setting will affect the yarn quality and the apron movement. The distance between nose bar and middle bottom roller should be less than apron thick ness or more than 3 mm to avoid apron buckling
if there is any diturbance in apron movement.

RING AND TRAVELLER:

- Ring diameter, flange width and ring profile depends upon the fibre, twist per inch, lift of the machine,maximum spindle speed, winding capacity etc.
- Operating speed of the traveller has a maximum limit, because the heat generated between ring and traveller should be dissipated by the low mass of the traveller with in a short time available.
- If the cotton combed yarn is for knitting, traveller speed will not be a limiting factor. Since yarn TPI is less, the yarn strand is not strong enough. Therefore the limiting factor will be yarn tension. Following points to be considered

1. for 12s to 24s , 42mm ring with 180 mm lift can be used
2. for 24s to 36s, 40 mm ring with 180 lift can be used
3. for 36s to 60s , 38 mm ring with 170 mm lift can be used
4. for 70s to 120s, 36 mmring with 160 mm lift can be used.
5. If winding is a problem, it is better to go for reduced production with bigger ring dia.
6. Anti-wedge ring profile is better, because of better heat dissipation
7. Elliptical traveller should be used, to avoid start-up breaks in hosiery counts

8. special type of travller clearer can be used to avoid accumulation of fibre on the traveller as traveller with waste does not perform well during start-up.

- For polyester/cotton blends and cotton weaving counts yarn strength is not a problem. The limiting factor will be a traveller speed. For a ring diameter of 40 mm, spindle speed upto 19500 should not be a problem. Rings like Titan(from Braecker), NCN(bergosesia) etc, will be able to meet the requirements.
- For spindle speeds more than 20000 rpm, ORBIT rings or SU-RINGS should be used. As the area of contact is more with this rings, with higher speeds and pressure, the heat produced can be dissipated without any problem. Normal ring and traveller profile will not be able to run at speeds higher than 20000 to produce a good quality yarn.
- ORBIT rings will be of great help, to work 100% polyester at higher spindle speeds. Because, of the tension, the heat produced between ring and traveller is extremely high. But one should understand,
that ,the yarn strength of polyester is very high. Here the limiting factor is only the heat dissipation. Therefore ORBIT RINGS with high area of contact will be able to run well at higher spindle speeds when
processing 100% polyester.
- While running 100% cotton, the fibre dust in cotton, acts like a lubricant. All the cottons do not form same amount of lubricating film. If there is no fibre lubrication, traveller wears out very fast. Because of this worn out or burn out travellers, microwelding occurs on the ring surface,< which results in damaged ring surface, hence imperfections and hairiness increases in the yarn.
- Lubrication is good with west african cottons. It may not be true with all the cottons from West africa. In general there is a feeling, cottons from Russia, or from very dry places, lubrication is very bad. If the fibre lubrication is very bad, it is better to use lighter travellers and change the travellers as early as possible.
- Traveller life depends upon the type of raw material, humidity conditions, ringframe speeds, the yarn count, etc. If the climate is dry , fibre lubrication will be less while processing cotton.
- Traveller life is very less when Viscose rayon is processed especially semi dull fibre, because of low lubrication. Traveller life is better for optical bright fibres.
- Traveller life is better for Poly/cotton blends, because of better lubricatiion between ring and traveller.
- Because of the centrifugal force excerted by the traveller on the yarn, the particles from the fibre fall on the ring where the traveller is in contact. These particles act like a lubricating film between ring and traveller.

RUBBER COTS AND APRON:

- For processing combed cotton, soft cots (60 to 65 degree shorehardness) will result in lower U%, thin and thick places.
- There are different types of cores (inner fixing part of a rubber cot)available from different manufacturers.
Aluminimum core,PVC core,etc. It is always better to use softer cots with aluminium core.
- When softer cots are used, buffing frequency should be reduced to 45 to 90 days depending upon the quality of the rubber cots, if the mill is aiming at very high consistent quality in cotton counts.

- If the lapping tendency is very high when processing synthetic fibres for non critical end uses,
It is better to use 90 degree shore harness cots, to avoid cots damages. This will improve the working and the yarn quality compared to working with 83 degree shore hardness.
- If rubber cots damages are more due to lapping, frequent buffings as high as once in 30 days will be of great help to improve the working and quality. Of course,one should try to work the ringframe without
lapping.

The basic reasons for lapping in the case of processing synthetic fibre is

- End breaks
- Pneumafil suction
- rubber cots type
- fibre fineness
- Oil content(electrostatic charges)
- department temprature and humidity
- Almost all the lappings orginate after an end break. If a mill has an abnormally high lapping problem the first thing to do is to control the end breaks,

1. after doffing
2. during speed change
3. during the maximum speed

by optimising the process paramters.
- It is obvious that fine fibres will have a stronger tendency to follow the profile of the roller. Therefore lapping tendency will be more.
- If the fibre is fine, the number of fibres in the cross section will be more, therefore lapping frequency will be more.
- If the pressure applied on the roller is more, then lapping tendancy will be more. Hence fine and longer fibres will have more tendency for lapping because of high top roller pressure required to overcome the drafting resistance.
- If the pneumafil suction is less, the lapping tendency will be more both on top and bottom roller. But the pneumafil suction depends on the fan diamater, fan type, fan speed, duct design, length of the machine, profile of the suction tube etc. If any one of the above can be modified and the suction can be improved, it is better to do that to reduce the lapping.
- The closer the setting between the suction nozzle and the bottom roller, the higher the suction efficiency and lower the lapping propensity.
- Higher roving twist will reduce the lapping tendency to some extent. Therefore it is better to have a slightly higher roving twist, provided there is no problem in ringframe drafting, when the lapping tendency is more
- With Softer rubber cots lapping tendency will be more due to more surface contact.
- The most minute pores, pinholes in the rubber cots or impurities in the cots can cause lapping. Therefore the
quality of buffing and the cots treatment after buffing is very important. Acid treatment is good for synthetic fibres and Berkolising is good for cotton.

- Electrostatic charges are troublesome especially where relatively large amount of fibre are being processed in a loose state e.g drawframe, card etc.Lapping tendency on the top roll increases with increasing relative humidity. The frequently held opinion is that processing performace remains stable at a steady absolute relative humidity, i.e. at a constant moisture content per Kg of dry air.

TWIST:

The strength of a thread twisted from staple fibres increases with increasing twist, upto certain level. Once it reaches the maximum strength, further increase in twist results in reduction in yarn strength

- Coarser and shorter fibres require more Twist per unit length than finer and longer fibres.
- Twist multiplier is a unit which helps to decide the twist per unit length for different counts from the same raw material.This is nothing but the angle of inclination of the helical disposition of the fibre in the yarn. This is normally expressed as

TWIST PER INCH = TWIST MULTIPLIER * SQRT(Ne)

- If the two yarns are to have the same strength, then the inclination angles must be the same.
- For 40s combed knitting application, if the average micronaire of cotton is 3.8 and the 2.5% span length is around 29 mm, Twist multiplier of 3.4 to 3.5 is enough . If the average micronaire is around 4.3, it should be around 3.6 to have better working in Ring frame.
- cotton combed knitting T.M. = 3.4 to 3.6
- cotton combed weaving T.M. = 3.7 to 3.8
- cotton carded knitting T.M. = 3.8 to 4.0
- cotton carded weaving T.M. = 3.9 to 4.2

The above details are for cottons of 2.5% span length of 27 to 30 mm and the average Micronaire of 3.7 to 4.4. For finer and longer staple, the T.M. will be lower than tha above.

In general for processing poly/viscose , the T.M. is as follows

- 51 mm, 1.4 denier fibre : T.M. = 2.7 to 2.9 for knitting application
- 51 mm, 1.4 denier fibre : T.M. = 2.9 to 3.1 for weaving application
- 44 mm, 1.2 denier fibre : T.M. = 2.9 to 3.0 for knitting application
- 44 mm, 1.4 denier fibre : T.M. = 3.0 to 3.1 for knitting application
- 38 mm, 1.2 denier fibre : T.M. = 3.1 to 3.3 for knitting application

The above detail is self explanatory

OTHERS:

The following ROVING parameters will affect the ring frame process parameters

- Roving T.M.
- Bobbin weight
- Bobbin height

- Higher the roving T.M., wider the back bottom roller setting or higher the break draft in ring frame.
- For combed material the creel height should be as low as possible in ringframe.
- Very long creel heights in ringframe, lower roving T.M. and heavier roving package will result in many long thin places in the yarn.(especially in combed hosiery counts)
- In general 16 x 6 " bobbins are used. This helps to increase the spare rovings per machine with higher creel running time. Therefore one should aim at increasing the bobbin weight as well as increasing the number of spare rovings in the ring frame.
- Normally 6 row creels are used in modern ring frames. Six row creels will accomodate more spare rovings compared to 5 row creels.(around 150 rovings for 1000 spindle machine.) Creel height should be as low as possible for cotton combed counts.Spare rovings will improve the operators efficiency.
- Shorter machines are always better compared to longer machines. But the cost per spindle will go up. For cotton , polyester/cotton blends, poly/viscose(upto 44mm length), number of spindles upto 1200,br> should not be a problem. But maintenance is more critical compared to shorter machines.
- For synthetic fibres with very high drafting resistance, it is better to use shorter machines, because the load on break draft gears and on second bottom rollers will be extremely high. If long machines are used and the maintenance is not good for such application, the bearing damages, gear damages, bottom roller damages etc. will increase. This will result in coarse counts, higher count C.V., long thin and thick places.
- Four spindle drive is always better compared to Tangential belt drive. Because small variation in machining accuracy of bolster , spindle beam etc will affect the spindle speeds, thereby the twist per inch. Waste accumulation between contact rollers, bent contact rollers, damaged contact rollers, oil spilling from any one spindle etc. will affect the spindle speeds and thereby TPI. The spindle speed variation between spindles in a 5 year old ringframe will be verh high incase of tangential belt ? drive compared to 4 spindle drive.
- Noise level and energy consumption will be low in 4 spindle drive compared to Tangential belt drive.
- Compared to Contact rollers, Jockey pully damages are nil. I have worked with 20 year old ring frames with
Jocky pulleys,but the variations in spindle speed between spindles is very less compared to a 5 year old ringframe with Tangential belt drive. I have made this comment based on my personal experience.
- When processing coarse counts at higher speeds, the air current below the machine is a big problem with 4 spindle drive . This is due to the more running parts like tinrollers and jockey pullys. This will lead to more fluff in the yarn, if humidification system is not good enough to suck the floating ,br> fluff.
- If spindle speeds is high for cotton counts, every end breaks will result in more fluff in the department due to the free end of the yarn getting cut by the traveller when the distance between traveller and the bobbin with the yarn is less. Higher the delay in attending the end break , higher the fly liberation.If the number of openings of return air system for a ringframe is less and the exhaust air volume is not sufficient enough, then fly liberation from an end break will increase the endbreaks and thereby will lead to multiple breaks. End break due to a fly entering the traveller will get struck with the traveller and will result in heavier traveller weight and that particular spindle will continue to work bad.
- Multiple breaks are very dangerous, as it will result in big variation in yarn hairiness and the ringframe working will be very badly affected due to heavier travellers because of the fluff in the traveller.
- Dry atmosphere in ringframe department will result in more yarn hairiness, more fly liberation and more end breaks.

- It is a good practice to change spindle tapes once in 24 months.Worn out spindle tapes will result in tpi variations which is determinetal to yarn quality.

VI. Quality Control

Process Control
Process conntrol studies of classing equipment operated by USDA are carried out periodically to determine the overall capability of the equipment with regard to accuracy. In turn, the study results are used to establish tolerance limits for measurement variations.

Equipment Performance Specifications
Minimum performance specifications of classing equipment are an integral part of the USDA procurement process. Specifications for the delivery of new equipment in 2000 included the following maximum allowable tolerances for accuracy and precision.

Fiber Property	Accuracy	Precision
Length (inch)	± 0.018	± 0 .012
Uniformity (percent)	± 1.200	± 0 .800
Strength (g/tex)	± 1.500	±1.000
Micronaire (units)	± 0 .150	± 0 .100
Color (Rd) (units)	± 1.000	± 0 .700
Color (+b) (units)	± 0 .500	± 0 .300
Trash (% area)	± 0 .100	± 0 .040

The term "accuracy" refers to how well an instrument measures a certain property in relation to its true value. The term "precision" refers to the ability of an instrument to produce the same measurement result time after time.

Laboratory Conditioning
Atmospheric conditions influence the measurement of cotton fiber properties. Therefore, the temperature and humidity of the classing laboratory must be tightly controlled. Temperature is maintained at 70°F, plus or minus 1 degree, and relative humidity is maintained at 65 percent, plus or minus 2 percent.

Sample Conditioning

Samples are conditioned to bring the moisture content to equilibrium with the approved atmospheric conditions. Conditioned samples will have a moisture content between 6.75 and 8.25 percent (dry weight basis). The samples may be conditioned passively or actively.

In passive conditioning, the samples are placed in single layers in trays which have perforated bottoms to allow free circulation of air. The samples must be exposed to the approved atmosphere until the specified moisture level is reached.

In active conditioning, a Rapid Conditioning unit is used in which air at the approved atmospheric conditions is drawn through the sample until equilibrium is reached. The time required to condition samples properly can be reduced to 10 minutes.

The moisture content of the conditioned samples is checked to verify that the appropriate moisture content has been reached. The moisture content of the samples to be tested should not vary more than 1 percentage point from the moisture content of the calibration cottons.

Laboratory Lighting

Lighting conditions in USDA laboratories are maintained to provide a minimum of 100 foot?candles of illumination at the classing level. Special lamps are used to provide the best true color perception. All surfaces in the laboratories are white, gray, or black, and the walls are off?white, to further enhance color perception.

Selection of Cotton for Calibration Usage

Cotton used for instrument calibration must pass rigorous screening procedures. As a first step, USDA conducts an intensive search for the most uniform bales of cotton in the current crop. Candidate bales are screened for uniformity of fiber quality by testing six samples drawn from throughout each bale. Bales that do not produce highly uniform measurement results are eliminated from further consideration. Bales that pass preliminary screening then undergo detailed analysis, as described below, to determine whether they meet USDA's high standards for certification and use as calibration cottons.

Establishing Values for Calibration Cotton

In addition to the requirement of high within bale fiber uniformity, the bales must also have the proper length and strength properties for their intended use. For example, a long/strong calibration cotton bale must have approximate length and strength values of 1 5/32nds of an inch and 33 g/tex, respectively. A short/weak calibration cotton bale must have approximate length and strength values of 31/32nds of an inch and 23 g/tex, respectively.

Candidate bales receive preliminary testing to ensure bale uniformity. Currently, five laboratories work together to establish values for calibration cottons; four are USDA facilities, and one is an independent laboratory from the research community. The independent lab operates under the same rigid specifications as the USDA. The laboratories perform a total of 180 tests per bale, and the results are used to further evaluate uniformity and to determine the values assigned to calibration cottons. For reference purposes, samples of previously established, or "benchmark", calibration cottons are included in the testing, along with samples from the candidate bales. Benchmark cotton values are established by the five laboratories mentioned above plus two international cotton laboratories. If the test results within a bale exceed prescribed limits, the bale is rejected. If all testing criteria are met, the bale is accepted and its contents packaged for distribution as calibration cotton.

Fiber Strength

Strength measurements are reported in terms of grams per tex. A tex unit is equal to the weight in grams of 1,000 meters of fiber. Therefore, the strength reported is the force in grams required to break a bundle of fibers one tex unit in size. The following tabulation can be used as a guide in interpreting fiber strength measurements. Strength measurements are made on the same beards of cotton that are used for measuring fiber length. The beard is clamped in two sets of jaws, one eighth inch apart, and the amount of force required to break the fibers is determined. Fiber strength is largely determined by variety. However, it may be affected by plant nutrient deficiencies and weather.There is a high?correlation between fiber strength and yarn strength. Also, cotton with high fiber strength is more likely to withstand breakage during the manufacturing process.

Degree of Strength	HVI Strength (grams per tex)
Very Strong	31 & above
Strong	29 -3 0
Average	26 – 28
Intermediate	24 – 25
Weak	23 & below

Micronaire

Micronaire is a measure of fiber fineness and maturity. An airflow instrument is used to measure the air permeability of a constant mass of cotton fibers compressed to a fixed volume. The chart below can be used as a guide in interpreting micronaire measurements.

Micronaire measurements can be influenced during the growing period by environmental conditions such as moisture, temperature, sunlight, plant nutrients and extremes in plant or boll population.

Fiber fineness affects processing performance and the quality of the end product in several ways. In the opening, cleaning, and carding processes, low micronaire, or fine?fiber, cottons require slower processing speeds to prevent damage to the fibers. Yarns made from finer fiber result in more fibers per cross?section, which in turn produces stronger yarns. Dye absorbency and retention varies with the maturity of the fibers. The greater the maturity, the better the absorbency and retention.

HIGH VOLUME INSTRUMENT SYSTEM

The testing of fibres was always of importance to the spinner. It has been known for a long time that the fibre characteristics have a decisive impact on the running behaviour of the production machines, as well as on the yarn quality and manufacturing costs. In spite of the fact that fibre characteristics are very important for yarn yarn proudction, the sample size for testing fibre characteristics is not big enough. This is due to the following

- The labour and time involvement for the testing of a representativesample was too expensive. The results were often available much too late to take corective action.
- The results often depended on the operator and / or the instrument, and could therefore not be considered objective
- one failed in trying to rationally administer the flood of the rawmaterial data, to evaluate such data and to introduce the necessary corrective measures.

Only recently technical achievements have made possible the development of automatic computer-controlled testing equipment. With their use, it is possible to quickly determine the more important fibre characteristics.

Recent developments in HVI technology are the result of requests made by textile manufacturers for additional and more precise fibre property information. Worldwide competitive pressure on product price and product quality dictates close control of all resources used in the manufacturing process.

Following are the advantages of HVI testing

- the results are practically independent of the operator
- the results are based on large volume samples, and are therefore more significant
- the respective fibre data are immediately available
- the data are clearly arranged in summerised reports
- they make possible the best utilisation of rawmaterial data
- problems as a result of fibre material can be predicted, and corrective measures instituted before such problems can occur

Cotton classification does not only mean how fine or clean, or how long a fibre is, but rather whether it meets the requirements of the finished product. To be more precise, the fibre characteristics must be classified according to a certain sequence of importance with respect to the end product and the spinning process.

The ability to obtain complete information with single operator HVI systems further underscores the economic and useful nature of HVI testing.

Two instrument companies located in the US manufacture these HVI systems. Both the systems include instruments to measure micronaire, length, length uniformity, strength, colour, trash, maturity, sugar content etc.

LENGTH:

The length measure by HVI systems used by the USDA is called upper-half-mean length. This is the average or mean length of the longest one-half of the fibres in the sample. The spinlab system uses the fibrosampler device to load the fibres on needles, the motion control system uses the Specimen Loader to capture the fibres in a pinch clamp. However the preparation of the length specimen for both systems includes combin to straighten and parallel   the fibres, and brushing to remove fibre crimp. The length measurement is then made by the instrument scanning along the length of the specimen to determine the length data.

The insturments are calibrated to to read in staple length. Length measurements obtained from the instrument are considerably more repeatable than the staple length determination by the classer. In one experiment the instrument repeated the same staple length determination 44% of the time while the classer repeated this determination only 29% of the time. Similarly, the instrument repeated to 1/32" on 76% of the samples, while the classer agreed on 71% of the samples to within 1/31".

The precision of the HVI length measurement has been improved over the last few years. If we take the same bale of cotton used in the earlier example and repeatedly measure length with an HVI system, over two-thirds of measurements will be in a range of only about 1/32 nd of an inch: 95% of the individual readings will be within 1/32nd of an inch of the bale average. In the 77000 bales tested, the length readings were repeated within 0.02" on 71% of the bales between laboratories.

LENGTH UNIFORMITY:

The HVI system gives an indication of the fibre length distribution in the bale by use of a length uniformity index. This uniformity index is obtained by dividing the mean fibre length by the upper-half-mean length and expressing the ratio as a percent. A reading of 80% is considered average length uniformity. Higher numbers mean better length uniformity and lower numbers poorer length uniformity. A cotton with a length uniformity index of 83 and above is considered to have good length uniformity, a length uniformity index below 78 is considered to show poor length uniformity.

Repeated measurements on a single bale of cotton show the length uniformity index measurement to have relatively low precision. About two-thirds of the measurements will occur within one unit of length uniformity; thus a bale with an average length uniformity index of 80 would have 68% of the readings occuring between 79 and 81, and 95% of hte readings occuring between 78 and 82. This does not seem too bad until one considers that most US upland cottons will have a length uniformity reading between 75 and 85.

Most organizations operate their HVI systems to use an average of 2 or 4 readings per bale for the length uniformity index. Using that number tests per bale, the USDA test of 77000 bales showed that laboratoriesat different locations agreed 68% of the time to within one length uniformity index unit.

In some cases low length uniformity has correlated with high short fibre content. However, in general the correlations between length uniformity index and short fibre content have not been very good. One important reason why the length uniformity index is a not a very good indicator of the short fibre content has to do with the fact that the HVI systems do not measure the length of any fibres shorter than about 4mm.

Another reason for the poor correlations between length uniformity index and short fibre content is that the short fibre content is related to staple length while the length uniformity index is fairly independent of staple length. As an example, the shorter staple cottons tend to contain higher amounts of short fibre than the longer staple cottons. Howeer, many short staple cottons have length uniformity index readings above 80.

MICRONAIRE:

The micronaire reading given by the HVI systems is the same as has been used in the commercial marketing of cotton for almost 25 years. The repeatability of the data and the operator ease of performing the test have been improved slightly in the HVI micronaire measurement over the original instruments by elimination of the requirement of exactly weighing the test specimen. The micronaire instruments available today use microcomputers to adjust the reading for a range of test specimen sizes.

The micronaire reading is considered both precise and reperable. For example, if we have a bale of cotton that has an average micronaire of 4.2 and repeatedly test samples from that bale, over two-thirds of thet micronaire readings will be between 4.1 and 4.3 and 95 %of the readings between and 4.0 and 4.4. Thus, with only one or two tests per bale we can get a very precise measure of the average micronaire of the bale.

This reading is also very repeatable from laboratory to laboratory. In USDA approx 77000 bales were tested per day in each laboratory, micronaire measurements made in different laboratories agreed with each other within 0.1 micronaire units on 77% of the bales.

The reading is influenced by both fibre maturity and fibre fineness. For a given growing area, the cotton variety generally sets the fibre fineness, and the environmental factors control or influence the fibre maturity. Thus , within a growing area the micronaire value is usually highly related to the maturity value. However, on an international scale, it cannot be known from the micronaire readings alone if cottons with different micronaire are of different fineness or if they have different maturity levels.

STRENGTH:

The strength measurement made by the HVI systems is unlike the traditional laboratory measurements of Pressley and Stelometer in several important ways. First of all the test specimens are prepared in a very different manner. In the laboratory method the fibres are selected, combed and carefully prepared to align them in the jaw clamps. Each and every fibre spans the entire distance across the jaw surfaces and the space between the jaws.

In the HVI instruments the fibres are ramdomly selected and automatically prepared for testing. They are combed to remove loose fibres and to straighten the clamped fibres, also brushed to remove crimp before testing. The mechanization of the specimen preparation techniques has resulted in a "tapered" specimen where fibre ends are found in the jaw clamp surfaces as well as in the space between the jaws.

A second important difference between traditional laboratory strength measurements and HVI strength measurements is that in the laboratory measurements the mass of the broken fibres is determined by weighing the test specimen. In the HVI systems the mass is determined by the less direct methods of light absorption and resistance to air flow. The HVI strength mass measurement is further complicated by having to measure the mass at the exact point of breaks on the tapered specimen.

A third significant difference between laboratory and HVI strength measurements is the rate or speed at which the fibres are broken. The HVI systems break the fibres about 10 times faster than the laboratory methods.

Generally HVI grams per tex readings are 1 to 2 units (3 to 5%) hihger in numerical value. In some individual cases that seem to be related to variety, the differences can be as much as 6 to 8% higher. This has not caused a great deal of problems in the US, perhaps because a precedent was set many years ago when we began adjusting our Stelometer strength values about 27% to put them on Presseley level.

Relative to the other HVI measurements, the strength measurement is less precise. Going back to our single bale of cotton and doing repeated measurements on the bale we shall find that 68% of the readings will be within 1 g/tex of the bale average. So if the bale has an average strength of 25 g.tex, 68% of the individual readings will be betweeen 24 and 26 g/tex, and 95% between 23 and 27 g/tex.

Because of this range in the readings within a single bale, almost all HVI users make either 2 or 4 tests per bale and average the readings. When the average readings are repeated within a laboratory, the averages are repeated to within one strength unit about 80% of the time. However, when comparisons are made between laboratories the agreement on individual bales to within plus or minus 1 g/tex decreases to 55%.

This decrease in strength agreement between laboratories is probably related to the difficulty of holding a constant relative humidity in the test labs. Test data indicate that 1% shift in relative humidity will shift the strength level about 1% . For example, if the relative humidity in the laboratory changes 3% (from 63 to 66%), the strength would change about 1 g/tex (from 24 to 25 g/tex)

COLOUR:

The measurement of cotton colour predates the measurement of micronaire, but because colour has always been an important component of classer's grade it has not received attention as an independent fibre property. However the measurement of colour was incorporated into the very early HVI systems as one of the primary fibre properties.

Determination of cotton colour requires the measurement of two properties, the grayness and yellowness of the fibres. The grayness is a measure of the amount of light reflected from the mass of the fibre. We call this the reflectance or Rd value. The yellowness is measured on what we call Hunter's +b scale after the man who developed it. The other scales that describe colour space (blue, red, green) are not measured becasue they are considered relatively constant for cotton.

Returning once again to the measurements on our single bale, we see that repeated measurements of colour are in good agreement. For grayness or reflectance readings, 68% of the readings will be within 0.5 Rd units of the bale average, and 95% within one Rd unit for the average.

As for yellowness, over two-thirds of these readings will be within on-fourth of one +b unit of the average, and 95% within one-half of one +b unit. The grayness (Rd) and yellowness (+b) measurements are related to grade through a colour chart which was developed by a USDA researcher. The USDA test of 77000 bales showed the colour readings to be the most repeateable of all data between laboratories; 87% of the bales repeated within one grayness(Rd) unit, and 85% repeated within one-half of one yellowness(+b) unit.

TRASH CONTENT:

The HVI systems measure trash or non-lint content by use of video camera to determine the amount of surface area of the sample that is covered with dark spots. As the camera scans the surface of the sample, the video output drops when a dark spot (presumed to be trash) is encountered. The video signal is processed by a microcomputer to determine the number of dark spots encountered (COUNT) and the per cent of the surface area covered by the dark spots (AREA). The area and count data are used in an equation to predict the amount of visible non-lint content as measured on the Shirley Analyser. The HVI trash data output is a two-digit number which gives the predicted non-lint content for that bale. For example, a trash reading of 28 would mean that the predicted Shirley Analyser visible non-lint content of that bale would be 2.8%.

While the video trash instruments have been around for several years, But the data suggest that the prediction of non-lint content is accurate to about 0.75% non lint, and that the measurements are repeatable 95% of the time to within 1% non-lint content.

SHORT FIBER CONTENT:

The measure of short-fiber content (SFC) in Motion Control's HVI systems is based on the fiber length distribution throughout the test specimen.

It is not the staple length that is so important but the short fiber content which is important. It is better to prefer a lower commercial staple, but with a much lower short-fibre content.

The following data were taken on yarns produced under identical conditions and whose cotton fibers were identical in all properties except for short-fiber content. The effects on ends down and several aspects of yarn quality are shown below.

	LOT -A, (8.6% SFC)	LOT-B (11.6% SFC)
Ends down / 1000 hrs	7.9	12.8
Skein strength (lb)	108.1	97.4
Single end strength g/tex	15	14.5
apperance index	106	89
Evenness (CV%)	16	17.3
Thin places	15	36
Thick places	229	364
Minor Defects	312	389

These results show that an increase of short-fiber content in cotton is detrimental to process efficiency and product quality.

HVI systems measure length parameters of cotton samples by the fibrogram technique. The following assumptions describe the fibrogram sampling process:

- The fibrogram sample is taken from some population of fibres
- The probability of sampling a particular fiber is proportional to its length
- A sampled fiber will be held at a random point along its length
- A sampled fiber will project two ends away from the holding point, such that all of the ends will be parallel and aligned at the holding point.
- All fibers have the same uniform density

The High Volume Instruments also provide empirical equations of short fibre content based on the results of cotton produced in the United States in a particular year.

Short Fibre Index = 122.56 - (12.87 x UHM) - (1.22 x UI)

where UHM - Upper Half Mean Length (inches)
UI - Uniformity Index

Short Fibre Index = 90.34 - (37.47 x SL2) - (0.90 x UR)

Where SL2 - 2.5% Span length (inches)
UR - Uniformity Ratio

In typical fibrogram curve, the horizontal axis represents the lengths of the ends of sampled fibers. The vertical axis represents the percent of fiber ends in the fibrogram having that length or greater.

MEASUREMENT OF MATURITY AND SUGAR CONTENT:

Near infrared analysis provides a fast, safe and easy means to measure cotton maturity, fineness and sugar content at HVI speed without the need for time consuming sample preparation or fiber blending.

This technology is based on the near infrared reflectance spectroscopy principle in the wavelength range of 750 to 2500 nanometers. Differences of maturity in cotton fibers are recognized through distinctly different NIR absorbance spectra. NIR technology also allows for the measurement of sugar content by separating the absorbance characteristics of various sugars from the absorbance of cotton material.

Cotton maturity is the best indicator of potential dyeing problems in cotton products. Immature fibers do not absorb dye as well as mature fibers. This results in a variety of dye-related appearance problems such as barre, reduced color yield, and white specks. Barre is an unwanted striped appearance in fabric, and is often a result of using yarns containing fibres of different maturity levels. For dyed yarn, color yield is diminished when immature fibres are used. White specks are small spots in the yarn or fabric which do not dye at all. These specks are usually attributed to neps (tangled clusters of very immature fibers)

NIR maturity and dye uptake in cotton yarns have been shown to correlate highly with maturity as measured by NIR. A correlation of R=0.96 was obtained for a set of 15 cottons.

In a joint study by ITT and a European research organization, 45 cottons from four continents were tested for maturity using the NIR method and the SHIRLEY Development Fineness/ Maturity tester(FMT). For these samples, NIR and FMT maturity correlated very highly (R=0.94).

On 15 cottons from different growth areas of the USA , NIR maturity was found to correlate with r2 = 0.9 through a method developed by the United States Department of Agriculture (USDA). In this method, fibres are cross-sectioned and microscopically evaluated.

Sugar Content is a valid indicator of potential processing problems. Near infrared analysis, because of its adaptability to HVI, allows for screening of bales prior to use. The information serves to selected bales to avoid preparaion of cotton mixes of bales with excessive sugar content. COTTON STICKINESS consists of two major causes- honeydew form white flies and aphids and high level of natural plant sugars. Both are periodic problems which cause efficiency losses in yarn manufacutring

The problems with the randomly distributed honeydew contamination often results in costly production interruptions and requires immediate action often as severe as discontinuing the use of contaminated cottons.

Natural plant sugars are more evenly distributed and cause problems of residue build-up, lint accumulation and roll laps. Quality problems created by plant sugar stickiness are often more critical in the spinning process than the honeydew stickiness. Lint residues which accumulate on machine parts in various processes will break loose and become part of the fiber mass resulting in yarn imperfections. An effective way to control cotton stickiness in processing is to blend sticky and nonsticky cottons. Knowing the sugar content of each bale of cotton used in each mix minimizes day-to-day variations in processing efficiency and products more consistent yarn quality. Screening the bale inventory for sugar content prior to processing will allow the selection of mixes with good processing characteristics while also utilizing the entire bale inventory.

The relationship between percent sugar content by NIR analysis and the Perkins method shows an excellent correlation of r2=0.95. The amount of reducing material on cotton fiber in the Perkins method is determined by comparing the reducing ability of the water extract of the fiber to that of a standard reducing substance. Using the NIR method, the amount of reducing sugar in cotton is measured.

The popularity of HVI testing has steadily gained since the introduction of the technology in the early 1960s.

Timely, valuable information, promotion of communication, standardisation of measurements, optimization of processes, development of new products and cost control are the outstanding benefits of technology.

Grades of U.S. Cotton

Official Standards of the U.S.						
Color Grade	**Symbols**	**Classer Color Code**	**Classer Leaf Code**	**Color Grade**	**Symbols**	**Classer Color Code**
White				**Spotted**		
Good Middling	GM	11	1	Good Middling	GM Sp	13
Strict Middling	SM	21	2	Strict Middling	SM Sp	23
Middling	Mid	31	3	Middling	Mid Sp	33
Strict Low Middling	SLM	41	4	Strict Low Middling	SLM Sp	43
Low Middling	LM	51	5	Low Middling	LM Sp	53
Strict Good Ordinary	SGO	61	6	Strict Good Ordinary	SGO Sp	63
Good Ordinary	GO	71	7			
				Tinged		
Light Spotted				Strict Middling	SM Tg	24
Good Middling	GM Lt Sp	12		Middling	Mid Tg	34
Strict Middling	SM Lt Sp	22		Strict Low Middling	SLM Tg	44
Middling	Mid Lt Sp	32		Low Middling	LM Tg	54
Strict Low Middling	SLM Lt Sp	42				
Low Middling	LM Lt Sp	52		**Yellow Stained**		
Strict Good Ordinary	SGO Lt Sp	62		Strict Middling	SM YS	25
				Middling	Mid YS	35

Each bale receives a separate grade for color and for leaf (trash). Color grade is determined by the classer with reference to a set of samples that are in custody of the U.S. Dept. of Agriculture. The

Leaf grades, identified by numbers 1 through 7, are represented by the amount of leaf trash in the White Grade standards. For example, a bale graded 31-4 has a Middling-White color grade and a leaf grade equivalent to the trash content of the Strict Low Middling White standard. Plus grades and gray grades have been eliminated from the grading standards.

Upland Staple Length		
Inches	HVI (in.)	Code*
<13/16	≤ 0.79	24
13/16	0.80-0.85	26
7/8	0.86-0.89	28
29/32	0.90-0.92	30
15/16	0.93-0.95	31
1	0.99-1.01	32
1-1/32	1.02-1.04	33
1-1/16	1.05-1.07	34
1-3/32	10.8-1.10	35
1-1/8	1.11-1.13	36
1-5/32	1.14-1.17	37
1-3/16	1.18-1.20	38
1-7/32	1.21-1.23	39
1-1/4	1.24-1.26	40
1-9/32	1.27-1.29	41
1-5/16	1.30-1.32	42
1-11/32	1.33-1.35	43
1-3/8	≤1.36	44

*32nds on an inch

White Specks

The term "white specks" describes a condition in dyed cotton fabric where small nep-like forms can be seen as white or, more accurately, lighter shade specks on the surface of the finished fabric. This condition can exist in both woven and knitted goods.

White specks are undyed spots on dyed fabric, and are commonly caused by neps. According to the American Society for Testing and Materials (ASTM D123-96, 1996), a nep is "a tightly tangled knot-like mass of unorganized fibers." This is to be differentiated from a mote, which is another impurity found in cotton consisting of a seed fragment encompassed by cotton fibers. Many researchers have studied neps over the decades, including types, formation, effects, and solutions.

Watson classified neps into two groups, mechanical and biological, and observed that mechanical neps are similar to the classical ASTM definition, where they are formed from mechanical actions on the fibers. They also reported that fibers with low micronaire values tend to form mechanical neps because the fibers are finer and less mature, and are therefore less rigid.

Biological neps are clumps of very immature fibers that can be found in seed cotton before mechanical processing has occurred. They also reported that fibers with low micronaire values (finer and immature fibers) tend to form mechanical neps because of the weak, poorly developed, less rigid fibers. Goynes et al. (1994) reported that because of low cellulose content of the undeveloped, flat, ribbon-like fibers, clumps of these fibers do not accept dye. Therefore, when a fabric is dyed, the mechanical and biological neps formed by fine or immature fibers create undyed spots in the finished fabric. These undyed spots are known as white specks.

Quality of a finished garment is determined by, among other things, the number of imperfections contained within the fabric. The more imperfections found in the cloth, the less value can be added to the product by the manufacturer. Since uniform surface color is a desirable aspect for fabrics, the inclusion of white specks is detrimental to fabric quality. White specks are a result of neps being included in the raw cotton product supplied to a processor or result from ensuing mechanical treatment.

The process of counting neps is very tedious and time consuming. Since the late 1930s, neps were counted manually using a back light (Helliwell, 1938) or a black background (Saco-Lowell, 1942). Even today, neps are being counted manually relying on visual inspection (Harrison and Bargeron, 1986; Hughs et al., 1988; Cheek et al., 1990; Smith, 1991). The manual counting is not only a time-consuming process, but also inconsistent and prone to error because it is very subjective.

Recently, many studies focused on automatic counting of neps and white specks. The Advanced Fiber Information System (AFIS) module has been used by many researchers to detect and count seed coat neps. Mor (1996) introduced a fiber contamination tester that detects sticky deposits by an electro-optical device and evaluates nonsticky parameters such as neps, trash, and seed coat fragment using an image processing system. Bel-Berger et al. (1994, 1995, 1996) used three different image processing hardware systems in analyzing the number and area of white specks found in dyed fabric. The area of white specks was calculated in terms of number of pixels.

The white speck counter developed consists of three major components: an illumination chamber, fabric transport mechanism, and image processing hardware and software. The illumination chamber is needed to provide uniform illumination on the fabric surface by blocking ambient light and furnishing a consistent light source. An aluminum roller is mounted on each side of the chamber so that a roll of dyed fabric can be mounted on a roller on one side of the chamber, and transported through the chamber to the other side onto the second roller. An image of the fabric is then captured by a black-and-white camera. Image analysis software counts the number of white specks in the image and measures the area of individual white specks.

The appearance of white specks on dyed and finished fabrics continues to be a sporadic and periodic problem for dyers, knitters, and spinners. Perhaps the most troubling aspect of this problem is the fact that its presence is not usually known until the fabric is dyed and finished. The severity of the occurrence can range from barely noticeable to rendering the material useless as first-quality goods. White specks are not normally visible in bleached or greige state goods.

White specks are actually small clusters of immature fibers (often "fused" together) which lie on the surface of the dyed fabric. Because these fibers are immature, or underdeveloped, their cell walls contain relatively little cellulosic material. This condition causes the fiber to take on a very flat and ribbon-like form. It is this flat form that, when seen on the surface of a dyed fabric, reflects light more efficiently than the surrounding fibers. This high reflectivity is perceived by the eye as being lighter in shade or, in some situations, as white specks.

All cottons (different varieties and bales) contain some amount of immature fibers. They are a natural product of the plant's developmental physiology. It is only when these immature and underdeveloped fibers reach certain concentrations in a bale, or group of bales, that the problem of white specks becomes an issue. Depending on their form and/or concentration level, immature fibers may or may not actually produce a white speck occurrence. This is part of the dilemma facing yarn manufacturers…There is no way of absolutely predicting (or avoiding) a white speck outbreak.

With that said, there are some general rules of thumb (based on empirical data and actual experience) that a spinner can follow in order to lower the probability of producing yarns which contain potential white specks.

1. For any given growth area and/or variety, higher micronaire values are less likely than lower micronaire values for producing white specks.

2. Higher maturity ratios are less likely than lower maturity ratios for producing white specks.

3. Stripper harvested cottons are more likely to produce white specks than spindle picked cottons. This is largely due to the tendency of the stripper to harvest bolls that are not fully mature.

4. Removing more waste through cleaning and carding (especially under the lickerin and fine openers) can minimize, or make an unacceptable situation acceptable. This suggestion should also imply that the introduction of reclaimed waste is a high risk activity for introducing white specks.

5. Maintaining a higher nep reduction factor on all cards can be very effective in minimizing white speck problems

These suggestions, even if followed to the letter, are still no guarantee that problems with white specks can be completely avoided or eliminated. This is especially true if the concentration of white speck producing material is high enough, but even a severe problem can be improved by their implementation.

The real crux of this very costly and frustrating situation is that there is no definitive or quantitative means of identifying, absolutely, the potential for this problem before it actually appears in dyed fabric. With all the indicators available to fiber users, none offer the ability to positively warn of a white speck outbreak. For this reason, many spinners, knitters, and dyers will perform sample dyeings on a given lot of yarn, which has been knitted into a small amount of fabric expressly for that purpose.

Since it should be clear at this point that complete avoidance is not possible, then it should also follow that the responsibility for white speck occurrences is very difficult to assign to one party in the production chain. If the conditions are shown to be favorable for white specks to appear, all parties must communicate quickly so that alternative processing and production decisions can be made in a timely manner.

Using known white speck containing fabrics for only bleached whites is one possible recourse. There are also many dyes that do a better, or worse, job of actually covering the problem. Dye selection (and shade choices) alone can prove to be a very effective means of dealing with this serious issue. Caustification of white speck infected fabrics has also shown to be quite successful.

There is no one, single best answer to this very frustrating issue. But, with the understanding and cooperation of all those involved, there may be found some fair compromises that could very well turn an unacceptable situation into one of shared acceptability.

INTRODUCTION

Yarn hairiness is a complex concept, which generally cannot be completely defined by a single figure. The effect of yarn hairiness on the textile operations following spinning, especially weaving and knitting, and its influence on the characteristics of the product obtained and on some fabric faults has led to the introduction of measurement of hairiness.

FACTS ABOUT YARN HAIRINESS:

Hairiness occurs because some fibre ends protrude from the yarn body, some looped fibres arch out from the yarn core and some wild fibres in the yarn.

- Pillay proved that there is a high correlation between the number of protruding ends and the number of fibres in the yarn cross-section.

- Torsion rigidity of the fibres is the most important single property affecting yarn hairiness. Other factors are flexural rigidity, fibre length and fibre fineness.

- **Mixing different length cottons-No substantial gain in hairiness.** Although the hairiness of a yarn could be reduced to some extent by the addition of a longer and finer cotton to the blend. The extent of reduction is not proportional to the percentage of the longer and finer component. This is probably due to the preferential migration of the coarser and shorter component, which has longer protruding ends, from the yarn body. The addition of wastes to the mixing increases the yarn hairiness; the effect of adding comber waste is greater than that of adding soft waste.

- **Blending-not a solution to hairiness.** The blended yarns are rather more hairy than expected from the hairiness of the components; a result similar to that found in cotton blends. This may be due to the preferential migration of the shorter cotton fibers; a count of the number of protruding ends of both types of fiber shows that there is more cotton fiber ends than expected, although the difference is not very great.

- The number of protruding ends is independent of twist, whereas the number of loops decreases when
  the yarn twist increases because of a greater degreee of binding between hte fibres owing to twist.
  The number of wild fibres decreases only very slightly with twist because of their position on the
  yarn periphery.

- The proportion of fiber ends that protrude from the yarn surface, counted microscopically has been found to be about 31% of the actual number of ends present in the yarn.
- If the length of the protruding fibre ends as well as that of the loops is considered, the mean value of the hairiness increases as the cross-sectional area increases and decreases with the length
  of the loops. The hairiness is affected by the yarn twist, since an increase in twist tends to shorten
  the fibre ends.

- Wild fibres are those for which hte head alone is taken by the twist while the tail is still gripped by the front drafting rollers.

- Fibre length influences hairiness in the sense that a greater length corresponds to less hairiness.

- Cotton yarns are known to be less hairy than yarns spun from man-made fibres. The possible reason
  for this is the prifile of the two fibres.Because of taper, only one end, the heavier root part of the
  cotton fibre, tends to come out as a protruding end in a cotton yarn. With man-made fibres, both ends
  have an equal probability of showing up as protruding ends.

- If the width of the fibre web in the drafting field is large, the contact and friction with the bottom roller reduce the ability of the fibres to concentrate themselves and hairiness occurs. This
  effect is found more in coarse counts with low TPI. This suggests that the collectors in the drafting field will reduce yarn hairiness.

- The yarn hairiness definitely depends on the fibres on the outer layer of the yarn that do not directly adhere to the core. Some of them have an end in the core of the yarn gripped by other fibres,
  whereas others, because of the mechanical properties of the fibre(rigidity, shape, etc.) emerge to
  the surface. During the twisting of the yarn, other fibres are further displaced from their central position to the yarn surface.

- Greater the fibre parallelization by the drawframe, lower the yarn hairiness.

- An increase in roving twist results in lower yarn hairiness, because of smaller width of fibre web in the drafting field.

- The number of fiber ends on the yarn surface remains fairly constant; the number of looped fibers reduces in number and length on increasing twist.
- Combed yarn will have low yarn hairiness, because of the extraction of shorter fibres by the comber.

- Yarn hairiness increases when the roving linear density increases . Yarn spun from double roving
  will have more hairiness than the yarn spun from single roving. This is due to the increased number of
  fibres in the web and due to higher draft required to spin the same count.

  Drafting waves increase hairiness. Irregularity arising from drafting waves increases with increasing draft. Yarn hairiness also may be accepted to increase with yarn irregularity, because fibers protruding from the yarn surface are more numerous at the thickest and least twisted parts of the yarn.

- The yarns produced with condernsers in the drafting field, particularsly if these are situated in the principal drafting zone, are less hairy than those spun without the use of condensers.

- **Higher spindle speed – high hairines**s. When yarns are spun at different spindle speed, the centrifugal force acting on fibers in the spinning zone will increase in proportion to the square of the spindle speed, causing the fibers ends as they are emerging from the front rollers to be deflected from the yarn surface to a greater extent. Further, at high spindle speed, the shearing action of the traveller on the yarn is likely to become great enough to partially detach or raise the fibers from the body of the yarn. As against the above factors, at higher spindle speeds the tension in the yarn will increase in proportion to the square of the spindle speed, and consequently more twist will run back to the roller nip, so that it is natural to expect that better binding of the fibers will be achieved. The increase in hairiness noticed in the results suggests that the forces involved in raising fibers from the yarn surface are greater than those tending to incorporate them within the body of the yarn at higher spindle speeds.

- **Higher draft before ring frame-less hairiness.** There is a gradual reduction of hairiness with increase in draft. In other word, as the fiber parallelization increases hairiness decreases. Reversing the card sliver before the first drawing head causes a reduction in hairiness, the effect being similar to that resulting from the inclusion of an extra passage of drawing.

- **Smaller roving package-less hairiness.** Yarn hairiness decreases with decrease in roving (doff) size, and yarn spun from front row of roving bobbins is more hairy and variable as compare to that spun from back row of rowing bobbins. It may be noted that though the trends are consistent yet the differences are non-significant:

- The spinning tension has a considerable influence on the yarn hairiness. The smaller the tension,
  the greater the hairiness. This is the reason why heavier travellers result in low yarn hairiness. If the traveller is too heavy also , yarn hairiness will increase.

- Spindle eccentricity leads to an increase in hairiness. Small eccentricities influence hairiness relatively little, but, from 0.5 mm onwards, the hairiness increases almost exponentially with eccentricity.

- The increase in hairiness due to spindle eccentricity, will be influenced by the diameter of ring, dia of bobbin, the shape of the traveller,the yarn tension, etc.

- Yarn hairiness will increase if the thread guide or lappet hook is not centred properly.

  Heavier traveler- less hairiness. The reduced hairiness of yarns at higher traveller weights can be explained by the combined effect of tension and twist distribution in the yarn at the time of spinning. The spindle speed remains constant, but the tension in the yarn will increase with increasing traveller weight, and better binding of the fibers would be expected.

  Parallel fibers-less hairiness. The improvement of yarn quality on combing is mainly ascribed to the reduction in the number of short fiber improvement in length characteristics, and fiber parallelization. There is a marked difference in hairiness of the carded yarn and the combed yarns, even with a comber loss of only 5%, but the effect on hairiness of increasing the percentage of comber waste is less marked. Combing even at low percentage waste causes a marked drop in hairiness relative to that of the carded yarn. In the case of combed cotton yarns the average value of hairiness decreases with increase in count, whereas in the case of polyester/ viscose blend yarns the hairiness increases with increase in count. In the case of polyester/ cotton blend yarns trend is not clear.

- Flat and round travellers do not influence yarn hairiness, but a greater degree of hairiness was observed with elliptical travellers and anti-wedge rings.

- Traveller wear obviously influences hairiness because of the greater abrasion on the yarn. Yarn hairiness increases with the life of the traveller.

- Bigger the ring diameter, lower the yarn hairiness.

- Yarn spun in a dry atmosphere is more hairy.

- Hairiness variation between spindles is very detrimental. Because these variation can lead to shade or appearance variaion in the cloth.

- The variation in hairiness within bobbin can be reduced considerably by the use of heavy travellers
  alone or by balloon-control rings with travellers of normal weight. In both the cases yarn is prevented
  from rubbing against the separators.

- Yarn hairiness is caused by protruding ends, by the presence of a majority of fibre tails. This suggests that these tails will become heads on unwinding and that friction to which the yarn is subjected will tend to increase their length. It is therefore logical that a yarn should be more hairy after winding.

- Repeated windings in the cone widning machine will increase the yarn hairiness and after three or four rewindings, the yarn hairiness remain same for cotton yarns.

- Winding speed influences yarn hairiness, but the most important increase in hairiness is produced by the act of winding itself.

- Because of winding, the number of short hairs increases more rapidly thatn the number of long hairs.

- In two-for-one twisters (TFO), more hairiness is produced because, twist is imparted in two steps. Yarn hairiness also depends upon the TFO speed, because it principally affects the shortest fibre ends.

- Hairiness variations in the weft yarn will result in weft bars