INFLUENCE OF OPEN END SPINNING PROCESS PARAMETERS ON COTTON YARN QUALITY

PROJECT REPORT

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ABSTRACT:-

In this work , an attempt was made how the changes in Open - End Spinning machine parameters influenced the yarn properties like Unevenness percentage , CSP , Hairiness , Single yarn strength , yarn appearance . By analyzing the results obtained in this study,the optimum process parameters for two yarn counts were obtained .

The influence of machine variables such as Rotor speed , Opening Roller speed and Seperator angle in Rotor Spinning on yarn quality were studied. The selection of opening roller speed influences the fibre individualisation and trash removal from input material . The productivity of Open -End Spinning machine is dependent on rotor speed . The spinning tension depends on Seperator angle .

With 100 % Cotton , two Counts (8's Ne & 12's Ne) were produced on Open - end Spinning machine . For each Count , number of yarn samples were produced by altering the Rotor speed , Opening roller speed and Seperator angle and analysis for their impact on various yarn properties were made.

The results indicates the following

* With the increase in rotor speed the uneveness of yarn increases.

* The yarn strength and lea CSP are reduced with the increase in rotor speed.

* With the increase in opening roller speed the imperfections are reduced.

* There is no significant effect in the hairiness and single yarn strength level by varing the seperator angle.

INTRODUCTION

INTRODUCTION :

Nearly for more than 150 years , Ring spinning was unchanged as the only method of producing yarns . Untill about 25 to 30 years ago the main aim of all development was to increase spinning economy by increasing the spinning productivity necessary in industrial countries , as higher wages , shorter working hours threatened to put them at competitive international market .

Ever since the introduction of Open-End spinning technology at the international Trade Fair in Brno in the year 1965 , the process is attaining world wide momentum both in machinery development as well as in yarn manufacture.

Rotor spinning is traditionally a coarse to medium Count spinning system . It is well known that the spinning of fine rotor yarns can cause excessive end breaks .

During the earlier days of the introduction of this technology, many mills with rotor spinning machine have been disappointed with the result they obtained . They were toying with the idea hat top quality yarn could be made from a poor quality Sliver simply by processing through OE systems.

In Open-End spinning machines, Spin Box is the Heart of spinning and influence the properties of yarn . Spin Box consists of Sliver feeding system , Opening system, Rotor section with sufficient suction for receiving the opened fibres from the opening zone , the opening roller not only to individualize but also to remove trash from fibres.

The fibres from opening roller are sucked through transport tube opening and onto the inner groove peripheral surface of the rotor centrifugal forces flying the fibres outwards and process them onto the collecting surface of rotor . The fibres are collected until the number of fibres per cross-section reaches that of desired Count . On inserting a parent yarn , through the doff tube , the fibre ring is opened out and twisted due to the rotor revolution and finally conceived as yarn which is drawn out through the take up system .

In the yarn formation , the required qualities such as yarn evenness , yarn strength and yarn appearance are achieved by means of various process parameters are settings . The important process parameters are opening roller speed ,Rotor speed and seperator angle . One is quality and another one is productivity .

LITERATURE SURVEY

LITERATURE SURVEY :-

Open –End rotor spinning has become a conventional spinning system and its population is second to ring spinning in short staple spinning sector . In INDIA, rotor spinning is limited to coarse Cotton yarns due to techno-economic reasons. Stalder(2) reported that for Cotton and acrylic the tenacity of coarse yarns remained uneffected with the rise in rotor speed , but fine yarns showed a slight drop in strengh . Gross berg et al observed that with increase in rotor speed the yarn tenacity increases . But Oxtoby (2) reported that higher rotor speed leads to a reduced elongation at break , and an increased variation of yarn tenacity , hence the statistical probability of an end-break increases.

Yarn irregularities and general imperfections such as neps also increase with rotor speed . Gnanasekar (8) observed that for 100% Cotton the strength did not vary much for rotor speeds 36000-60000 rpm. In the case of waste mixing , the strength remained more or less same up to 50000 rpm and thereafter it started falling . as there are differing views regarding influence of rotor speed and other parameters on yarn properties , a study was carried out to find the effect of opening roller speed, rotor speed and twist multiplier on yarn properties.

The yarns were conditioned for 48 hours at standard atmospheric condition before testing . The yarn CSP was tested by SITRA state Electronic Lea CSP tester. Single yarn strength and elongation at break where measured by Uster Tensorapid and Unevenness and Hairiness were measured by Uster Tester.The influence of rotor speed and opening roller speed on yarn properties are shown . As the rotor speed increases in general, there is a reduction in CSP and tenacity of yarns. Similar trends are observed for elongation at break for these yarns, as shown ..

When the rotor speed increases for a given twist the yarn delivery speed increases and to maintain the linear density of yarns, feed rate also gets increased correspondingly . This affects adversely the efficiency of the combing roller on individualising the fibres , so the fibres get deposited in the rotor groove in bunches and not in single fibres . This Hypothysis is corroborated by increasing number of thick places and neps with increased rotor speed, the yarn strength becomes lower. The fibres coming out of the combing roller normally contain a lot of hooks ,loops and other fibre deformation . Ishtiaque (5) have reported recently that the percentage of reversed fibres in rotor during peeling-off increases or increasing rotor speed.

At higher rotor speed , the centrifugal force acting on fibre ring at rotor groove is higher . This higher centrifugal force makes the resultant yarn more compact and when these yarns are put under strainless fibre slippages occur causing lower elongation at break values . Also , yarn tension during spinning is proportional to the square of the rotor speed with increase in rotor speed , the spinning tension increases at a much higher rate and the yarn produced under higher spinning tension is generally characterized by a lower breaking elongation .

The yarn Hairiness increases with higher rotor speed . For 10's Ne yarn , the effect is not so significant but for 6 Ne yarn the effect is more serious . As it is discussed earlier , the percentage of reversed fibres increases with higher rotor speed , and more fibres can go in the transverse direction causing increased Hairiness . For 6's Ne yarn, the number of fibres per cross-section is higher compared to 10's Ne yarn. This may be the reason for having more effect on 6's Ne yarn.

The effect of opening roller speed is not so distinct. However , there is a trend ,at lower rotor speed , the yarn CSP decreases with higher opening roller speed where as at higher rotor speed the yarn tenacity increases with opening roller speed . The function of the opening roller is to

individualise the fibres .There is an optimum combination between opening roller speed and rotor speed. In general , better opening of fibre helps in achieving better yarn properties . At lower rotor speed , delivery speed is lower and so the relative opening speed becomes faster at higher opening roller speed and that may cause fibre damage.

At higher rotor speed, the optimum opening roller speed reaches higher level due to higher delivery speed. The effects of twist on the yarn properties are reported. It can be seen that at lower rotor speed (45000) rpm , the yarn tenacity and CSP increase with higher TM. When the rotor speed is 50000 rpm , the tenacity and CSP decrease with higher TM. The change in Twist shows insignificant effect on elongation at break.

At higher rotor speed , the slippage increases and as well as the slippage increases at higher TM values . At higher rotor speed , larger fibre tufts are deposited on the rotor groove. These tufts show a larger degree of fibre orientation and due to their increased stiffness, there is a reduced twisting ability. These may be the reasons for having negative effect at higher rotor speed. Similarly it was reported by Oxtoby(2) that in order to give increased yarn strength , the maximum possible twist level drops rapidly at higher rotor speeds with the result that the range of possible twist becomes more restricted at higher rotor speed.

In rotor spinning , the oritically individual fibres are deposited in layers on the surface of the rotor to form a fibre ring . This ring is then withdrawn in the reverse direction . In practise , however , the things differ from theoritical considerations, so that the fibre hooks ,loops and belts and the other types of deformations are created. Hence the rotor spun yarns are more disordered than those produced on ring frames. The difference of structure also renders different properties to the yarn formed on this system.

Initially , the Count spinning limit was up to a certain mark and this was considered a waste . But after due to understanding of the process , technical and technological innovations, the Count limit slowly shifted to relatively finer side . Today , practically ,one can spinning any yarn ,upto 40 Ne ,on rotor spinning machines . Besides the basic considerations like the rotor speed , opening roller speed , geometry of the rotor and wire on opening roller , the response of the machine is different as regards the yarn quality , spinning performance and its utility . This is mainly due to the basic factors like the fibre length ,fineness maturity and trash and microdust levels in the Sliver.

Further , the fabric made from rotor spun yarns also exhibit different properties than the fabrics made from ring yarn. Since this is an era of knitted garments the use of rotor yarns , for manufacturing them has created a lot of interest. But still certain properties like feel of the fabric and yarn performance on the machines need to be studied in detail. The yarn formation and quality in rotor spinning are greatly influenced by the quality of Sliver fed to it viz, the length of the fibres ,more importantly the length uniformity the fineness of the fibre and the dust present . There are other aspects like the individualised state of fibre for better transportation and accumulation for better quality of yarn .

Hence it is obvious that the Sliver quality will be governed by the route followed in the preparatory stages, carding is the basic process which contributes greatly to the cleaning of feed material ,seperation of fibres and also very sensitive to any change in some of its parameters and the Sliver quality is affected considerably which in turn affects the yarn quality.

CARDING CONSIDERATIONS :-

In carding the cylinder ,flats and doffer zone play an important role. As the cylinder with a layer of fibres approaches doffer ,the fibre ends that lash on to the doffer surface get caught by doffer wire points while the other ends are still held by cylinder wires .The cylinder quality posses the transfer region on account of a very high surface speed .The fibres are pushed

between the doffer wires as a result of tension developed in them. This packing action enables the doffer to take fibres so that number of fibres per unit area is about 2-3 times than that of cylinder.

If doffer speed is increased more ,wire points are made available to the cylinder and eventhough the surface speed ratio between cylinder and doffer decreases , the transfer efficient increases on account of more packing as the doffer speed is increased . However , packing action is less efficiency if doffer speed is increased very much. The transfer efficiency and hook for processes go hand in hand .

The increase in production rate through doffer speed will enhance cylinder loading and it turn affects the neps, uniformity and cleanliness of the card-sliver if other parameters remain same . So the yarn quality in term of U% (uster) imperfections. Strength of the yarn and appearance grade
show significant changes. The given ordinary mixing quantity sliver by adjusting the flat speed or flat strip waste. With the increase in flat speed by keeping all the other parameters same, the flat strip waste will increase, but at the same time because of better combing action the trash left in sliver will be reduced and there will be some reduction in short fiber.

The strength of yarn may show some positive changes, but the curve of strength will be less, imperfection and U% measured on the uster will have no change. The gain will be obtained in yarn and aesthetic appearance.

COMBING CONSIDERATIONS:

There are two distinct ways of combing as usually done, it scratch combing and normal combing. These names are derived from the amount of waste removed combing eliminates short fibres neps and husk fragments. The advantages obtained because of combing in rotor spinning are as follows.

- The weakest point is stronger by 10% - 20%
- Yarn suitable for optimum fabric quality
- Spinning limit can be moved up.
- Rotor deposits are low.
- Performance of yarn is enhanced by further processing.
- Improved handle and abrasion properties.

The additional waste extracted can be compensated by additional cost of selling. The use of combing in rotor spinning has opened a new field of application for the yarns manufactured on this system.

SLIVER QUALITY CONSIDERATIONS:

The sliver quality is of at most importance in rotor spinning as compared to ring spinning . The important ones are:

- Length uniformity of fiber
- Trash in the sliver
- Fineness of the fibre

The above factors decide the weight of the sliver, weight variation, trash and microdust level, which in turn affects the yarn quality and performance of the machine.

LENGTH CONSIDERATION:

The length of the fibre doesnot play the same role as it does it ring spinning. At the same time, there is interrelationship with the length and the rotor diameter as follows:

Rotor diameter (mm) = Staple length * 1.2 → (1)

The twist flows into the rotor groove until it reaches a specific point. There is the peel-off point and so called "Tie – in – Zone ", ie, the part in rotor groove where fibre strand is twisted. The length
and stability of the tie-in-zone are the two parameters defining spinning stability and this in turn probability of breakage.

The length of the tie-in-zone varies around an average value during spinning. A yarn break will occur when this length temporarily falls below a critical value, and where a trashy particle obstructs twists propagation.

Greater the fibre length and more importantly more homogenous is the fibre length distribution and more is stability of the spinning process. The process stability improves when more fibres are added to the cross section of the yarn. The number is governed by the fineness of the fibre for a given count of yarn. So fibre fineness is the next consideration described in the next section. .

FIBRE FINENESS CONSIDERATIONS:

The fibre fineness is one of the principal factors defining yarn breakage behaviour and spinning limit. The optimum number of fibres (nf) in the cross section can be calculated as follows

$$nf = \frac{15030}{nc\ (yarn) * micro} \qquad \rightarrow (2)$$

A relationship from rieter shows that the fibre becomes coarser the yarn strength drops down. The coarse fibre also leads to deterioration in spinning conditions and also necessitates use of light twist multiplier. A minimum of 100 fibres in the cross section of yarn are needed to give the desired strength of the yarn. The strength is mainly affected by the strength of the fibre which is the next consideration.

FIBRE STRENGTH:

The fibre strength and yarn strength in case of rotor yarns are linearly related. The majority fibres in open end rotor yarns are

hooked and shortening of the fibre extent increases wire length. Thus the strength of the yarn is expected to be lower than ring yarn.

Some relations have been worked out to estimate the count strength product (csp) of yarns

$$csp = k \, (ls/f) \wedge 0.35$$

where k = constant

l = 50% span length in mm

s = 1/8" strength in g/tex

f = fibre fitness in micro

TRASH CONSIDERATIONS:

As mentioned earlier, the preparatory processes like blowroom, carding, combing and to some extent drawing can eliminate the majority of trash and dust excepting seed coat fragments.

The trash as a whole is categorised as follows:

- Trash (Large particles)
- Fibre fragments
- Dust (small particles)

The large particles usually don't constitute a problem. The trash seperation system of the rotor spinning machine can effectively remove this type of impurity. The small particles on the other hand even if the kinetic energy imported by acceleration forces is often insufficient to dislodge the impurities from the combing roller teeth. In case of those particles which are seperated out the trajectory become generally flatter because of aerodynamic buoyancy. Some of the large particles may reach rotor from this category. The contamination of such particles with the fibre ring leads to increase in short term irregularity and a consequent reduction in yarn strength and elongation.

In the case of seed coat fragments the trash seperation process at any stage in most of the time becomes ineffective. These seed coat fragments adversely affect the twist propagation in the rotor groove. They also impair the yarn appearance and in turn fabric appearance. Even if the seed coat fragments adversely affect the twist propagation in the rotor groove. They also impair the yarn appearance and in turn fabric appearance. Even if the seed coat fragments are removed by opening roller they are deposited in the rotor groove, causing fly generation. Small fragments may remain in the groove as disruptive deposits. Dust accumulation not only impairs yarn regularity and increases hairiness, but also, has great association with the honey dew present in the cotton.

The degree of accumulation of dust increases with increasing residual dust content in the sliver, higher rotor speeds and smaller rotor diameter. The variation in twist due to the dust accumulation may give the fault 'bar' in the fabric or 'moire' effect. All the end breaks in rotor spinning are not solely due to trash, but on analysis the end break is a disturbance in the yarn forming process. The proportion and causes, are as indicated as following

ñ Formation of Tufts : 31.5%

ñ Dirt and fly accumulation at trash removal slot and dragging of the same on the rotor : 28.5%

ñ Impurities in drawn sliver, which are not removed in blow room (or) carding : 24%

ñ Deposits on rotor : 16%

The change in trash level and consequently reduced deposits on rotor can be obtained by the fed material.

EFFECT OF ROTOR VARIABLES ON TOTAL NUMBER OF NEPS AND THICK PLACES :

The effect of rotor machine variables on the number of neps and thick places . The response surface equation for total number of neps shows that the rotor speed and rotor diameter affect the neps significantly. The increase in neps is attributed to the higher incidence of sheath fibres and poorer opening as the rotor speed increases . With the increase in rotor diameter from 36mm to 46mm , neps increase but with further increase in rotor diameter from 46mm to 56mm they decrease . According to BARRELLA (1). when the rotor diameter increases, the distance between the consecutive belts within a given length decreases but belt length increases and these are responsible for neps in yarn.

It is observed from the response surface equation for total number of thick places that the increase in rotor speed increases the thick places but the increase in opening roller speed decreases the thick places. Thick places increase with the increase in rotor diameter up to 48mm and then decrease with further increase in rotor diameter up to 56mm.Abraded neps are influenced only by opening roller speed. An increase in rotor speed and opening roller speed increases the unopened and fused-fibre neps. With increase in rotor diameter , the unopened neps first increase and then decrease whereas the fused -fibre neps decrease.

Loose-belt neps invariably increase with the Increase in rotor speed , rotor diameter and opening roller speed. Tight - belt neps do not show any trend with the change in either rotor speed or opening roller speed. With an increase in opening roller speed at a particular rotor diameter, the surface-clustered thick places increase, but with the increase in rotor diameter, they initially increase and then decrease. Abraded thick places increase invariably with an increase in opening roller speed and rotor, but with an increase in rotor diameter they first decrease and then increase. Belt thick places increase with an increase in rotor speed. Unopened thick places increase with the increase in opening roller speed, but they first increase and then decrease with the increase in rotor diameter. With increase in rotor speed upto 60,000 rpm, the unopened thick places increase significantly and with further increase in rotor speed, increase is not much.

P.CHELLAMANI (7) , states that suppose if a trash particle is present in the feed sliver and fed to the groove of the rotor spinner. These trash particles contain among other things ,about 15 to 20% of substances which are sticky in nature and therefore they attach themselves very firmly into the rotor groove . For every one revolution of the rotor , the peel-off point passes over the trash particle once; during which time some fibres are picked up and retained by the trash particle from the out going yarn . That particular spot will appear as a thin place followed by the normal yarn is equal to the circumference of the rotor and the length of this thin place is equal to the length of the trash .

During this process , the fibres collected over the trash particles are picked up by the outgoing yarn at random and that spot will appear as a thick place. Therefore the periodic occurrence of thin place followed by normal yarn with random incidence of thick place is termed as Moire effect in yarn . This process will continue till the trash particle grows sufficiently big in size to interfere with the process of yarn formation and creates an end break . It has been found that spinning is possible till the length and thickness of the trash particle grows to 10mm and 6mm , respectively .

In case more than one trash particles are anchored on the groove , thin places will occur more frequently with distance between them equal to the distance two particles .

Barre in OE Fabrics :

Suppose if dust particles present in the sliver fed to the OE spinner , as in the case of trash particles, these dust particles also get themselves attached on the rotor groove . Since these dust particles are very small in size , they can neither create an end break, nor collect fibres on them,but grow steadily in length and thickness as spinning proceeds . After an hour or so , these dust particles form a complete ring of about 1mm , thickness as shown and start collecting fibres from the outgoing yarn . This process makes the linear density of outgoing yarn somewhat lower than the normal yarn . Spinning can continue for a considerable time after the ring has been formed and the yarns produced at this point of time will be finer than the nominal count. An end break will occur when the ring reaches a certain thickness(about 2 to 2.5 mm). Immediately after the break, the rotor is cleaned before the spinning is restarted and yarns thus produced will have normal thickness. After about an hour when a complete ring of dust is formed inside the groove the quality of yarn will again start deteriorating in terms of linear density and this process will report after every break . The product produced in this process will have long thin places followed by normal yarn . If these yarns are used as weft , the fabric will have weft bars and if they are used as warp , the fabric will have barre effect .

In addition to these , the fouling of rotor by the dust also causes ;

a) Reduction in the abrasion resistance of yarn

b) Increase in the number of protruding fibres from the surface of yarn.

It is quite clear from the above that trash and dust particles present in the feed material are the main culprits for major yarn faults . In addition , they were also found to be responsible for nearly 30 to 50% of the breaks during rotor spinning . With a view to obtaining better quality and higher productivity, reduction of these foreign matters in the feed material for OE system should receive top priority.

The trash particles are generally heavier and larger than fibres. These trash particles could be removed even during opening of the sliver by the opening roller of the rotor spinning machine. If the introduction of II and III generation rotor spinning machines where in the trash ejection system is an integral part, slivers containing trash level as 0.82 to 1% could be successfully processed without any appreciable deterioration in yarn quality. To obtain a sliver of about 0.8 to 1% trash content is well within the reach of a spinner with appropriate adjustment of process parameters in preparatory machines. So every effort must be directed towards reducing the dust content in the feed sliver to the OE spinner to the minimum extent possible. Since, these dust particles are smaller in size, shorter in length and therefore lighter in weight than the cotton fibres.(The diameter of cotton fibres varies from 12 to 25 micrometers where as that of the microdust particles varies between 0.5 to 10 micrometer). They can't be removed by the normal beater gridbar system of cleaning which indeed is probably responsible for creating a certain amount of fine dust. Special treatments, therefore, are to be given for cotton fibres meant for OE spinning to get rid of the problem of dust.

LOKESH SUKLA (9) indicated in his study about raw material preparation.There are three types of rotor spinning machines – long staple machine for above 100mm fibre; medium staple machine upto 100mm fibre; and short staple machine for upto 60mm fibre.

The short staple machine is suitable for production of yarn from cotton, cotton waste(secondary material), cotton noil, and manmade fibre.

About 10per cent of the rotor spun yarn are produced by clean waste from cotton spinning mills. Data reveals that the fibre length required for rotor spinning are as follows.

COTTON: Waste< =7/8" suitable up to 14"; short stable< =1" suitable up to 14"; and medium staple < =11/8" suitable up to 35".

MANMADE FIBRES: Staple fibre < =60mm suitable up to 50".

In rotor spinning fibre length does not play a dominant role in yarn characteristic whereas fibre fineness is having much importance.

In order to obtain acceptable yarn strength, a greater number of fibres is needed in the yarn cross section. Hence finer fibre is preferred in the range of: cotton2.8-4.5/micronaire, and manmade fibre 1-1.7 d tex. The yarn strength is reportedly less by 20 to 40 per cent in comparison to ring spun yarn. Therefore fibre of the greatest possible strength should be selected.

BLOW ROOM LINE :

The dirt and dust are strong disturbing factors in rotor spinning. A high cleaning effect is needed, but with fibre treatment as gentle as possible. This implies a blow-room line with a few but very effectively operating machines. Hence not all blow-room installations are appropriate for rotor spinning. High quality equipment is essential.

CARDS :

Card usually reduces the dirt content to less then 0.1 – 0.2 per cent. With regard to dust removal, the blow room, carding room, and draw frames are each expected to extract about one-third of the dust. Web crushing at the delivery of the card often brings about a significant improvement in the cleaning effect for cotton with a medium to high dirt content. Therefore card sliver must exhibit a high degree of evenness.

DRAW FRAMES :

Here the dust is removed, but the main task is to ensure high sliver evenness over both short and long length. Silver evenness over short to medium length leads to count variation in the yarn. The third task of the draw frame lies in the creation of a high degree of parallelism.

OPENING ROLLER :

The teeth of the opening roller pass at high speed upto 35m/s through the fibre beard being slowly pushed forward by the feed roller. The opening roller rotates at between 5,000 to 10,000 rpm usually 6,500 and 8,00 rpm. Higher speed of rotation is chosen where material throughput is high and lower speed where material throughput is low. The diameter of the opening roller lies between 60 and 80mm. The opening-roller clothing is of two types – metallic and needle – depending upon the type of fibre, fibre characteristic, and material throughput.

FIBRE FEED TUBE :

Fibre feed into rotor, after opening, the fibre passes to the rotor opening, the fibre passes to the rotor through a closed tube formed as a flow passage serves as a means of guidance. Transport of fibres in this is effected by an air flow generated by suction of air from the hermatically sealed rotor housing. Fibre can move into the rotor in one of two ways either axially or tangentically. In axial feed, centrifugal force distributes the fibres within the collection groove in a purely random fashion and in accordance with an umbrella principle. In tangential feed, the rotation of the rotor and a corresponding air circulation within the rotor ensure ordered deposition of fibre in the groove. An incoming fibre strikes an inclined wall and is pressed outwards by an enormous centrifugal force over 1,00,000 times the weight of fibre. This causes the fibre to slide downwards on the rotor wall while being accelerated in the peripheral direction and to be deposited on the other fibres in the collection groove.

FORMATION OF YARN :

The yarn is pressed against the rotor wall by the high centrifugal force and the separation point therefore rotates within the rotor. Each revolution of the yarn at this point inserts one turn of twist. The yarn twist penetrates into the fibre ring in the collection groove, where the fibres are to be bound to form yarn.

FALSE TWIST EFFECT :

The spun yarn, withdrawn through a passage in the navel to the yarn, therefore rolls continually on the trumpet-shaped maouth piece of the nozzle. The partial rolling of the yarn gives rise to false twist between the twisting in point for the fibres and the navel.

INFLUENCE OF THE ROTOR :

It is the main spinning element of the rotor spinning machine. Yarn quality, yarn character, working performance, productivity, costs, etc., all depend chiefly upon the rotor. The most important parameters of the rotor that exert influence are the rotor form, groove, rotor diameter, rotational speed, rotor bearing, coefficient of friction between the fibre and the rotor wall, air flow conditions inside the rotor, and liability of fouling. Yarn can be withdrawn opposite the rotor shaft or through it. The latter arrangement gives a better self-cleaning effect because the yarn is dragged over the floor of the rotor.

NAVEL :

The yarn leaves the rotor via a tube in the middle of the rotor. Turning of the rotor causes the yarn to roll continually on the surface of the specially formed mouth-piece (novel) of this tube. The novels are made up of steel while the surface contacting the yarn is of steel, chrome-plated steel or ceramic. There are further distinctions drawn between surfaces smooth grooved, knurled, spiral or ribbed.

METHODOLOGY

METHODOLOGY :

A fibre mixing comprising of the following were chosen for the study . DCH 32 cotton from yellow picking- 5%, comber noils -60%, flat strips-25%, pneumafil&bonda waste-5%, and useable waste-5%.The mixing were processed through LAKSHMI RIETER blow room line using standard speeds and settings.

The pre cleaning operation for the flat strips and yellow picking cotton is done before the actual blow room passage starts. For that purpose an mixing bale opener and step cleaner were used. The yellow picking cotton contains 10 to 15% of trash. Jayadhar, V797 and J34 are the common varities of cotton fibres used for the open end yarn mixing.

MATERIAL FLOW DIAGRAM:

MIXING BALE OPENER

↓

MONO CYLINDER

↓

ERM CLEANER

↓

RESERVE BOX

↓

HOPPER FEADER

↓

TWO BLADED BEATER

↓

KIRSCHNER BEATER

↓

LAP FORMING UNIT

↓

CARDING

↓

DRAW FRAME

↓

ROTOR SPINNING

For processing the above mixing of fibres LAKSHMI RIETER blow room line was used.The lap produced from the lap forming unit consists of a lap hank of 0.00134 Ne at a deliveryrate of 8 meters /min.The lap containing up to 1% of trash. The CV% of lap is 2 to 2.5%.

The lap is then processed in a LR C1/2 carding mashine. The speeds of the various parts of the card are, licker-in -900 rpm, cylinder - 380 rpm, flats speed -9"/min and doffer speed -25 rpm.The amount of draft is given in the range of 95 to 96. The delivery sliver hank is 0.135 Ne. The sliver containing the trash of 0.5 to 0.6%.The CV% of the sliver is 3 to 4%.

The card sliver is processed through a LR DO/6 draw frame. The number of doubling are six.The drawn sliver hank is 0.135Ne and the delivery rate is 240 m/min.The break draft is 1.74 and total draft is 5.6.The settings in the main drafting zone is 40mm and back zone is 36mm.

The rotor spinning machine consists of the following details.

Make : Sodal spin

Model : SS12

Rotor groove : T

Navel : R 10

Number of heads : 12

Gauge : 230mm

Rotor size : 54mm

Opening roller size : 64.6mm

Manufactrurer of the spin box : CSG ELITEX , CZECH REPUPLIC

Max speed of the rotor : 65,000 rpm

Max speed of the opening roller : 9000 rpm

Max delivery speed : 100 m/min

Yarn count possible : 4's Ne to 20's Ne

Power :

Main drive : 3 HP

Rotor drive : 3HP

Opening roller drive : 2HP

Suction drive : 2HP

To study the effect of spinning process parameters on rotor spun yarn the following two counts are chosen,

1. 8's Ne
2. 12's Ne

For that study the following parameters are changed to the following levels,

S.L NO	PARAMETERS	LEVELS
1.	ROTOR SPEED (RPM)	40,000,45,000 and 50,000
2.	OPENING ROLLER SPEED(RPM)	6500,7500
3.	SEPERATOR ANGLE	15, 45 degree

It should be under stood that only one parameter was changed at a time while all other parameters were kept at the optimum level. Totally in this manner 12 samples of rotor spun yarn for each count were obtained. Approximately half kilogram of yarn was produced for each sample.

SAMPLE PLAN FOR 8's COUNT

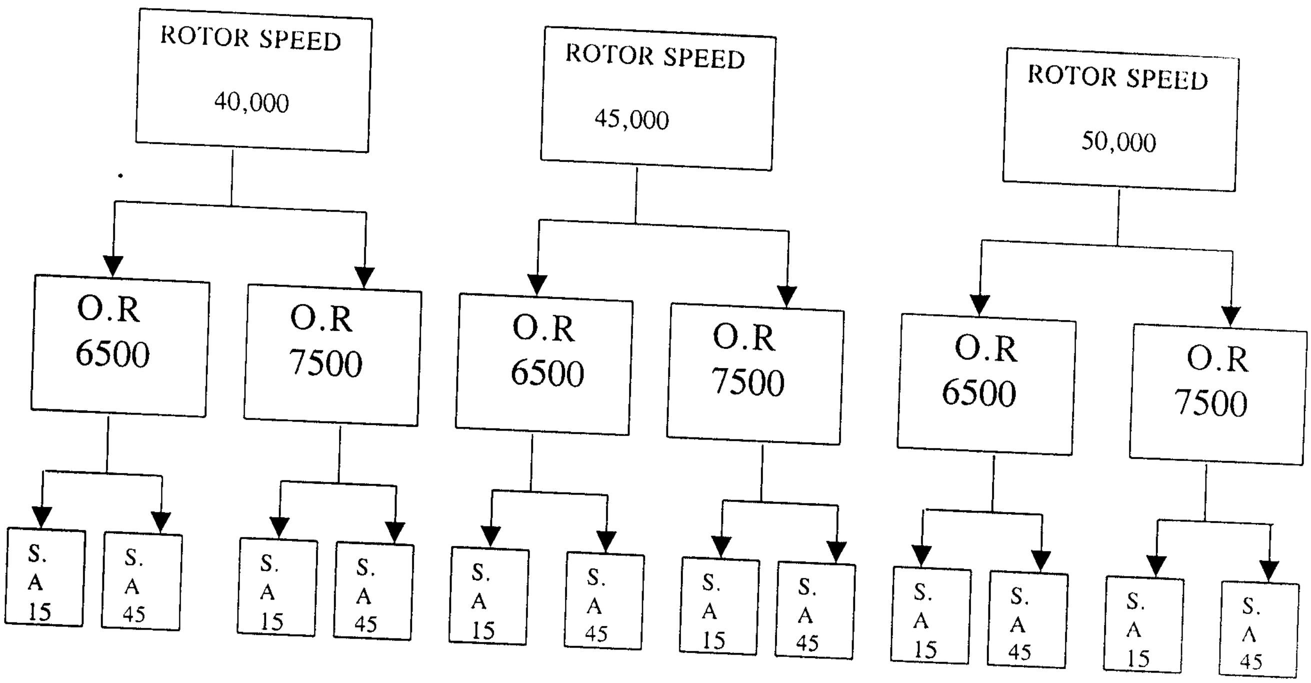

Table 1

SAMPLE PLAN FOR 12's COUNT

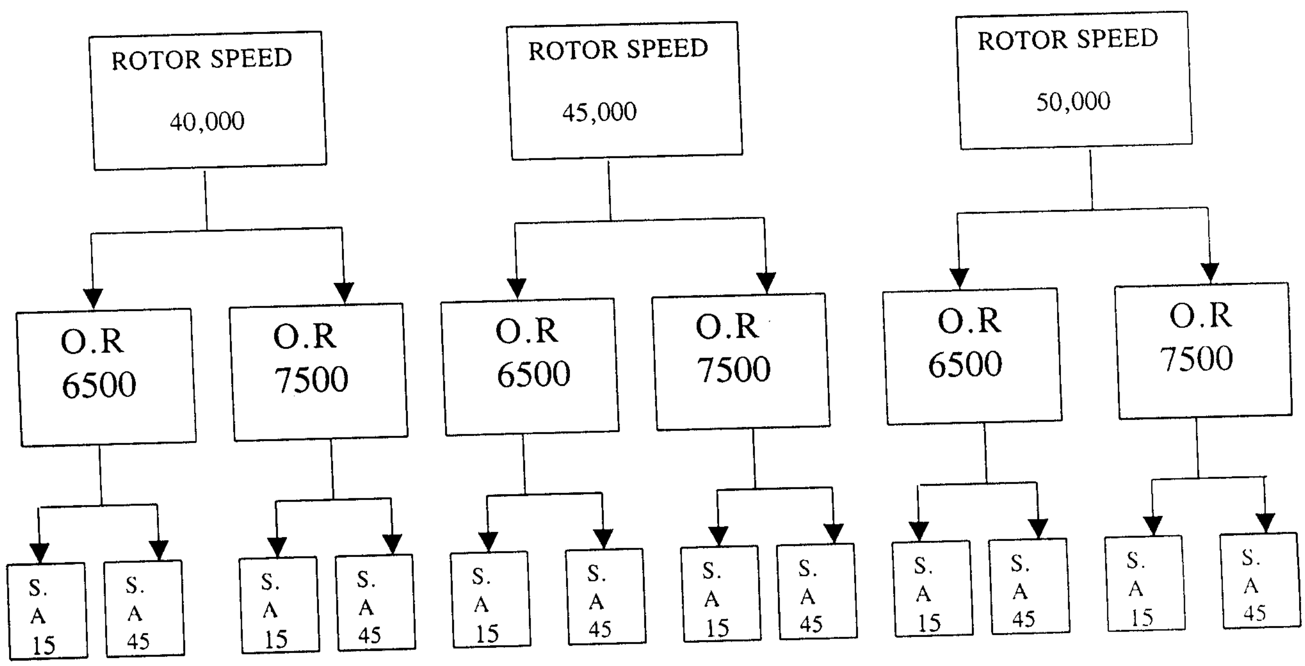

Table 2

At first we kept the rotor speed of 55,000 rpm for the productivity point of view. But at that speed due to higher delivery rate frequent yarn breakages are occured. It is because the fibre length are randomly varying and the proper yarn formation at rotor is not happened. So, we reduced rotor speed to 50,000 rpmas the max limit.At that speed yarn formation is good and no end breakages are occured.Hence we decided the three levels as 40,000, 45,000 and 50,000 rpm.The opening roller speed is kept in the range of 6500 and 7500 rpm for the experiment.

The normal usable range of seperator angles are 15, 45 and 90. In our practice frequent end breakages are occured at 90 seperator angle.This is due to the short and medium staple fibres are present in our mixing . So, the yarn formation becomes very difficult at that particular angle, That is why we kept the seperator angle in the two ranges as 15 and 45 degree.

For the production of 8's count we started experiment by keeping the rotor speed as 40,000 rpm and the opening roller speed as 6500 rpm.The samples are taken by keeping the seperator angle at 15 and 45 respectively.

Keeping the same rotor speed ,by changing the opening roller speed to 7500 rpm and the samples are produced for 15 and 45 degree angles.

Then the rotor speed is changed to 45,000 rpm . For that rotor speed the other 4 samples are taken by the combination of choosing the opening roller speed as 6500 rpm and 7500 rpm and the seperator angle as 15 and 45 degree angles.The rotor speed is now raised to 50,000 rpm. Further 4 samples are collected by varying the combination of 15 and 45 degree seperator angles and 6500 rpm and 7500 rpm opening roller speeds. By the same way for the 12's count the set of 12 samples are produced.

TESTING:

The following tests were conducted for all the above samples and the test results are enclosed .

1. Count and its CV%
2 Lea strength and its CV%
3. Lea CSP and its CV%
4. Evenness test
5. Imperfections
6 .Single thread strength
7. Hairiness

The sliver CV% is determined by using the wrap block and Electronic digital balance.The leas of 120 yards of the yarn are produced by the automatic wrap reel.These leas are tested for strength testing by using the RMW lea strength tester. By the principle of constant rate of traverse the pointer is moved on the graduated scale and the reading is directly measured.

The evenness and imperfections are tested on ELCOT MASET-03 Evenness tester.The tester works under capacitance principle. It is a computerised instrumentation to determine the irregularity of slivers ,rovings and yarns (ie) U%,Thin places, Thick places and Neps.The samples are tested at speed of 100 m/min for a length of 100 meter per sample.

The single yarn strength is tested by the textechno statimat M tester. For the gauge length of 500mm at aspeed of 500 m/min.The Hairiness test is carried out by the Star tester I-B. The test speed is 50m/min for alength of 100 meter per sample.

RESULT AND DISCUSSION

1. COUNT = 8's Ne

ROTOR SPEED = 40,000 rpm

OPENING ROLLER SPEED = 6500 rpm

SNO	NAME OF THE TEST	S.A 15°	S.A 45°
1.	COUNT (Ne)	7.65	7.90
2.	COUNT CV%	3.96	4.02
3.	LEA STRENGTH (Lbs)	201.5	191.87
4.	LEA STRENGTH CV%	6.58	8.55
5.	LEA CSP (HANK)	1541	1516
6.	LEA CSP CV%	5.55	7.04
7.	U%	10.92	11.31
8.	IMPERFECTION (per 1 Km)	198	228
9.	HAIRINESS (per 100 meter)	700.5	524.5
10.	ELONGATION (%)	7.78	7.25
11.	TENACITY (R Km)	8.03	10.42

II

ROTOR SPEED = 40,000 rpm

OPENING ROLLER SPEED = 7500 rpm

SNO	NAME OF THE TEST	15"	45"
1.	COUNT (Ne)	7.87	7.99
2.	COUNT CV%	2.22	3.83
3.	LEA STRENGTH (Lbs)	189	190.08
4.	LEA STRENGTH CV%	4.94	6.09
5.	LEA CSP (HANK)	1487	1519
6.	LEA CSP CV%	4.71	5.20
7.	U%	10.75	11.07
8.	IMPERFECTION (per 1 Km)	206	223
9.	HAIRINESS (per 100 meter)	473.5	513.5
10.	ELONGATION (%)	7.47	7.62
11.	TENACITY (R Km)	8.51	8.34

III

ROTOR SPEED = 45000 rpm.

OPENING ROLLER SPEED = 6500 rpm

SNO	NAME OF THE TEST	15°	45°
1.	COUNT (Ne)	8.02	7.87
2.	COUNT CV%	4.88	4.11
3.	LEA STRENGTH (Lbs)	184.3	191.5
4.	LEA STRENGTH CV%	7.85	6.56
5.	LEA CSP (HANK)	1479	1507
6.	LEA CSP CV%	8.58	6.50
7.	U%	11.6	11.71
8.	IMPERFECTION (per 1 Km)	235	265
9.	HAIRINESS (per 100 meter)	311	388.5
10.	ELONGATION (%)	6.95	6.90
11.	TENACITY (R Km)	8.25	7.57

IV

ROTOR SPEED = 45000 rpm

OPENING ROLLER SPEED = 7500 rpm

SNO	NAME OF THE TEST	15°	45°
1.	COUNT (Ne)	7.71	7.87
2.	COUNT CV%	3.08	3.73
3.	LEA STRENGTH (Lbs)	182.6	186.98
4.	LEA STRENGTH CV%	6.82	8.28
5.	LEA CSP (HANK)	1408	1472
6.	LEA CSP CV%	6.38	7.41
7.	U%	11.49	11.99
8.	IMPERFECTION (per 1 Km)	295	305
9.	HAIRINESS (per 100 meter)	304.5	351.5
10.	ELONGATION (%)	7.07	6.75
11.	TENACITY (R Km)	7.80	7.92

V

ROTOR SPEED = 50000 rpm

OPENING ROLLER SPEED = 6500 rpm

SNO	NAME OF THE TEST	15°	45°
1.	COUNT (Ne)	7.81	7.92
2.	COUNT CV%	3.95	2.77
3.	LEA STRENGTH (Lbs)	190.9	185.87
4.	LEA STRENGTH CV%	7.45	7.47
5.	LEA CSP (HANK)	1491	1471
6.	LEA CSP CV%	6.30	5.90
7.	U%	11.98	12.19
8.	IMPERFECTION (per 1 Km)	219	231
9.	HAIRINESS (per 100 meter)	235	231.5
10.	ELONGATION (%)	6.58	6.30
11.	TENACITY (R Km)	6.67	7.24

VI

ROTOR SPEED = 50000 rpm

OPENING ROLLER SPEED = 7500 rpm

SNO	NAME OF THE TEST	15°	45°
1.	COUNT (Ne)	7.96	7.73
2.	COUNT CV%	3.24	4.13
3.	LEA STRENGTH (Lbs)	185.49	186.04
4.	LEA STRENGTH CV%	7.83	8.16
5.	LEA CSP (HANK)	1476	1438
6.	LEA CSP CV%	5.80	5.24
7.	U%	12.18	13.13
8.	IMPERFECTION (per 1 Km)	385	394
9.	HAIRINESS (per 100 meter)	224.5	279
10.	ELONGATION (%)	6.41	6.52
11.	TENACITY (R Km)	6.26	7.88

COUNT = 12's Ne

I ROTOR SPEED = 40000 rpm

OPENING ROLLER SPEED = 6500 rpm

SNO	NAME OF THE TEST	15°	45°
1.	COUNT (Ne)	11.98	11.95
2.	COUNT CV%	4.01	3.36
3.	LEA STRENGTH (Lbs)	101.85	101.76
4.	LEA STRENGTH CV%	9.60	5.92
5.	LEA CSP (HANK)	1220	1216
6.	LEA CSP CV%	6.35	4.21
7.	U%	12.94	12.90
8.	IMPERFECTION (per 1 Km)	338	275
9.	HAIRINESS (per 100 meter)	502.5	482
10.	ELONGATION (%)	6.61	7.02
11.	TENACITY (R Km)	8.27	8.42

II ROTOR SPEED = 40000 rpm

OPENING ROLLER SPEED = 7500 rpm

SNO	NAME OF THE TEST	15°	45°
1.	COUNT (Ne)	11.91	11.92
2.	COUNT CV%	2.85	3.95
3.	LEA STRENGTH (Lbs)	102.9	101.48
4.	LEA STRENGTH CV%	5.35	7.49
5.	LEA CSP (HANK)	1225	1208
6.	LEA CSP CV%	4.65	5.55
7.	U%	12.60	13.23
8.	IMPERFECTION (per 1 Km)	224	339
9.	HAIRINESS (per 100 meter)	392.5	442.5
10.	ELONGATION (%)	6.91	6.59
11.	TENACITY (R Km)	9.06	9.10

III ROTOR SPEED = 45000 rpm

OPENING ROLLER SPEED = 6500 rpm

SNO	NAME OF THE TEST	15°	45°
1.	COUNT (Ne)	12.03	11.73
2.	COUNT CV%	2.94	2.62
3.	LEA STRENGTH (Lbs)	99.80	101.81
4.	LEA STRENGTH CV%	6.91	5.43
5.	LEA CSP (HANK)	1201	1194
6.	LEA CSP CV%	5.04	3.66
7.	U%	13.80	13.39
8.	IMPERFECTION (per 1 Km)	367	445
9.	HAIRINESS (per 100 meter)	327.0	314
10.	ELONGATION (%)	6.34	6.39
11.	TENACITY (R Km)	7.98	7.84

IV ROTOR SPEED = 45000 rpm

OPENING ROLLER SPEED = 7500 rpm

SNO	NAME OF THE TEST	15°	45°
1.	COUNT (Ne)	11.81	12.04
2.	COUNT CV%	1.99	3.22
3.	LEA STRENGTH (Lbs)	98.36	97.30
4.	LEA STRENGTH CV%	5.59	7.37
5.	LEA CSP (HANK)	1161	1171
6.	LEA CSP CV%	4.92	5.05
7.	U%	13.44	13.71
8.	IMPERFECTION (per 1 Km)	457	479
9.	HAIRINESS (per 100 meter)	297	318.5
10.	ELONGATION (%)	6.65	6.44
11.	TENACITY (R Km)	8.76	7.77

V ROTOR SPEED = 50000 rpm

OPENING ROLLER SPEED = 6500 rpm

SNO	NAME OF THE TEST	15°	45°
1.	COUNT (Ne)	11.40	11.38
2.	COUNT CV%	2.71	3.73
3.	LEA STRENGTH (Lbs)	101.88	99.65
4.	LEA STRENGTH CV%	5.66	7.72
5.	LEA CSP (HANK)	1161	1134
6.	LEA CSP CV%	3.87	5.71
7.	U%	14.15	15.36
8.	IMPERFECTION (per 1 Km)	439	491
9.	HAIRINESS (per 100 meter)	233.5	190.0
10.	ELONGATION (%)	6.24	6.00
11.	TENACITY (R Km)	6.72	6.02

VI ROTOR SPEED = 50000 rpm

OPENING ROLLER SPEED = 7500 rpm

SNO	NAME OF THE TEST	15°	45°
1.	COUNT (Ne)	11.68	11.77
2.	COUNT CV%	3.42	2.49
3.	LEA STRENGTH (Lbs)	95.87	94.16
4.	LEA STRENGTH CV%	6.09	7.43
5.	LEA CSP (HANK)	1120	1109
6.	LEA CSP CV%	3.83	6.47
7.	U%	13.96	14.23
8.	IMPERFECTION (per 1 Km)	438	444
9.	HAIRINESS (per 100 meter)	192	195
10.	ELONGATION (%)	6.18	6.14
11.	TENACITY (R Km)	7.43	7.05

RESULT AND DISCUSSION:

The optimum speed for a given size of the rotor is exceeded, the strength of yarn detoriorates with increase in speed. As the opening roller speed increases gradualy the correspondingly lea strength increases also. At lower opening roller speed the lea strength is very minimum.

A common trend of reduction in values with increase in rotor speed is followed on all cases.A reason behind this is a poor fibre arrangment at higher rotor speeds &that makes the yarn weaker.As the opening roller speed increases better fibre opening & reguler distribution of fibre inside the rotor takes place & hence increased in CSP is obtained.

As the rotor speed increases,the irregularity increases and the yarn become more uneven for the two count levels. At lower rotor speed, the imperfection is lower.Uneven distribution and more allignment of fibres inside the groove at higher speed makes the yarn more irregular.Higher the opening roller speed lower the imperfection and lower the unevenness percentage.

When the rotor speed exceeded yarn breaks occur either due to high tension in the yarn or the impairing of twist flow in the rotor groove caused by excessive resistance of the fibres in the groove of twisting .For the lower rotor speed results in a reduction of yarn tension which adversely affects the false twisting function of the delivery nozzle and is seen in to result in an increase in the number of end breakags. So,we cannot process the particular mixing above 50,000 rpm of rotor and below the 40,000 rpm of rotor.

The fibre velocity inside the spinning unit (transfer tube) however,is governed by airflow conditions.Hence, it is indipendent of the rotor speed & remain basically unchanged. Incase, increase in rotor speed leads to a raise in the fibre flux (Number of fibres per cross section) in the areabetween opening zone and rotor which eventually affects the yarn quality. It is not surprising therefore, that it is primarily the number of neps which increases with an increase in rotor speed.

The yarn quality parameters are also affected by such a reduced degree of of fibre seperation. The influence in opening roller speed at higher feed rate , increases the number of beats per cm of fibre but this improvement in fibre seperation is acheived at the cost of fibre damage.

The increase in the total number of imperfections with increased rotor speed is quite siginicant for the two count of yarn.the insufficient time for the fibers to get aligned themselves at high rotor speed inside the rotor groove from hooks and bends due to improper allignment are increased number of closely wound wrappers also get counted as neps are the probable reasons for higher imperfections.

The variation in opening roller speed has little influence on the amount of imperfections.The reduction in the number of imperfection per kilometer even at the highest opening roler speed itself significant. It clearly shows that for a given count twist and rotor speed the intensity of opening roller speed neither increase nor decrease the number of imperfections/ km.

Hihger rotor speeds bring down yarn elongation which is mainly beacuse of the higher centrifugal force acting makes the yarn more compact and this higher compactness reducess the yarn slippage which in turn results in loss in elongation.

The extension of the yarn decreases with incasing rotor speed due to gereater centrifugal force and hence tension on the yarn. Hence at a given speed, rotor of small diameter produce yarns with better extensibility than those spun with large size.

The single yarn strength almost same for lower rotor speed but after a certain limit ie.,15,000 rpm for 8 's Ne the strength falls down. Like the rotor speed, the single yarn strength decreases to a certain limit (up to 7500 rpm for both the counts) and the single yarn strength increases gradually.

The hairiness in ternms of hairs / km for different rotor speeds for the two counts. There is no definite trend followed in any case. Almost in all cases there is a overall reduction in hairs/km which increases in rotor speed, opening roller speed. Particularly a significant reduction in hairs/cm is noticed with increase in TPI value.

For the short staple fibre variety the smaller seperator angle is prefered, for the medium and larger staple fibere variety the larger the angle of seperator is prefered. The seperator angle has neglibile influence on the yarn properties.

CONCULSION

CONCLUSION:

Analysing the study reveals, we have concluded the following.

Rotor speed:

- ñ At lower rotor speed the strength is high , when increasing rotor speed after certain limit strengthfalls down.
- ñ Increasing the rotor speed the unevenness percentage increases.
- ñ At higher rotor speed higher the imperfections.
- ñ Increasing the rotor speed, the hairiness reduces.
- ñ With lower rotor speed, the single yarn strength is high.

Opening roller speed:

- ñ Increasing the opening roller speed, lea CSP is increased.
- ñ At higher opening roller speed lower the unevenness percentage.
- ñ Increasing opening roller speed imperfections are reduced.
- ñ Higher the opening roller speed lower the hairiness value.

Seperator angle:

- ñ At lesser angle the count cv% is minimum.
- ñ At higher angle the end breakages are increases.
- ñ Imperfections are more at higher angle.

From the above studies, for open end spinning the following are recommended.

1. From the quality point of view, rotor speed of 40,0000, opening roller speed of 7500 and 15 degree seperator angle gives better results for both the counts.

2. From the productivity point of view, the rotor speed of 45,000, opening roller speed of 7500 and 15 degree seperator angle is prefered with optimum quality for both the counts.

REFERENCE

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ANNEXURE

COUNT – 8's Ne

1.ROTOR SPEED Vs. LEA STRENGTH

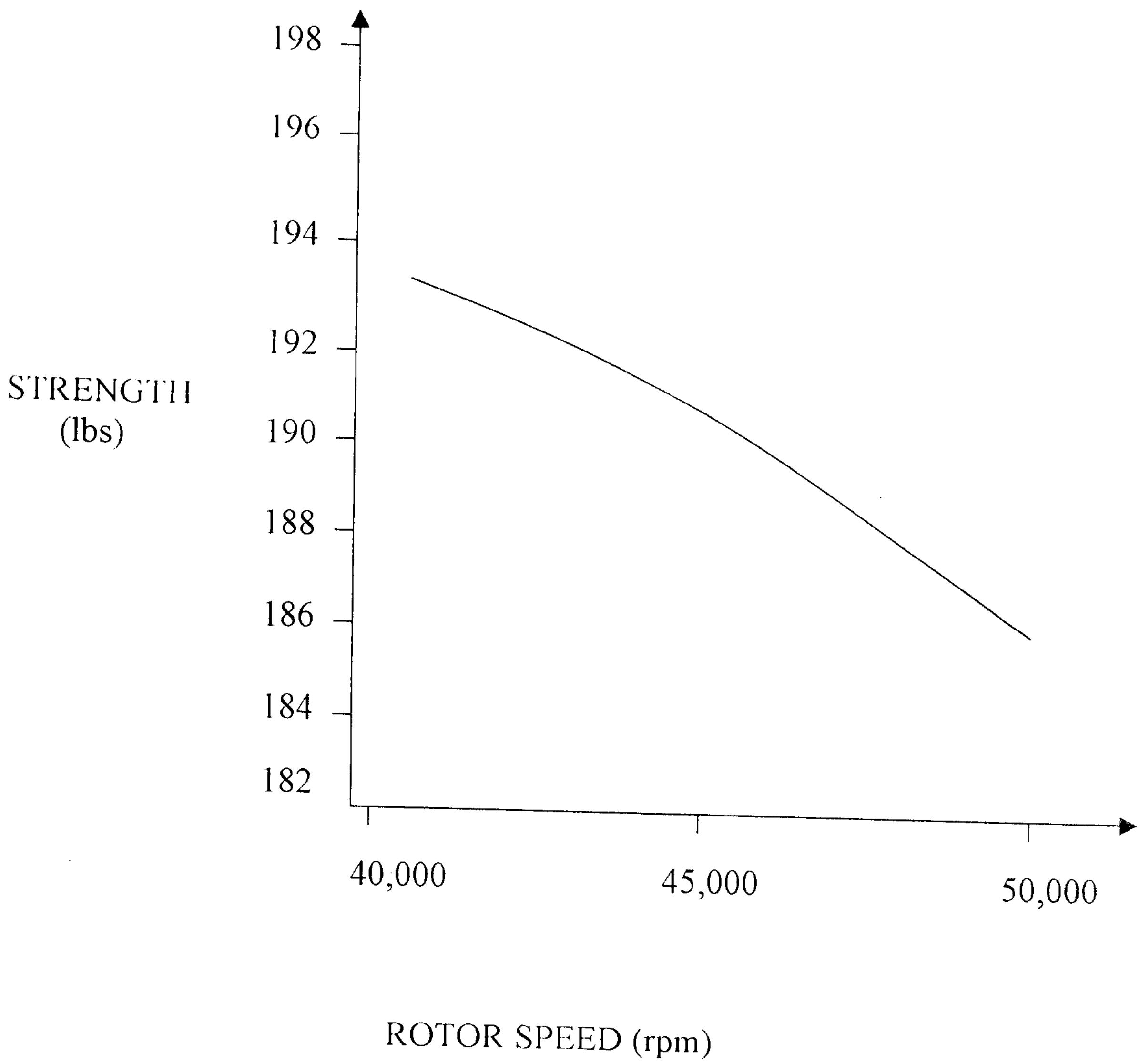

Fig 1

COUNT – 8's Ne

2. ROTOR SPEED Vs. UNEVENNESS

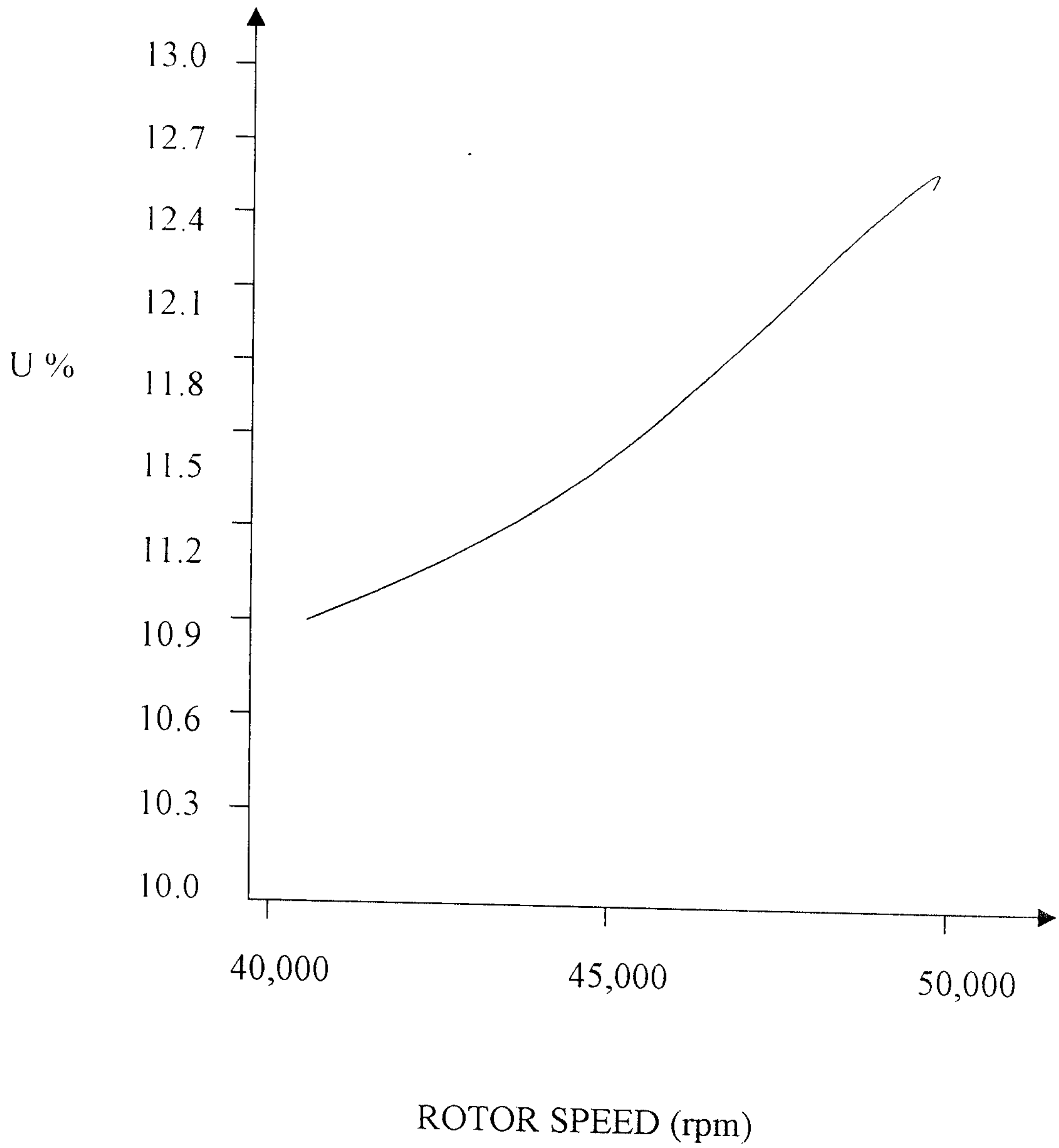

Fig 2

COUNT – 8's Ne

3. ROTOR SPEED Vs. HARINESS

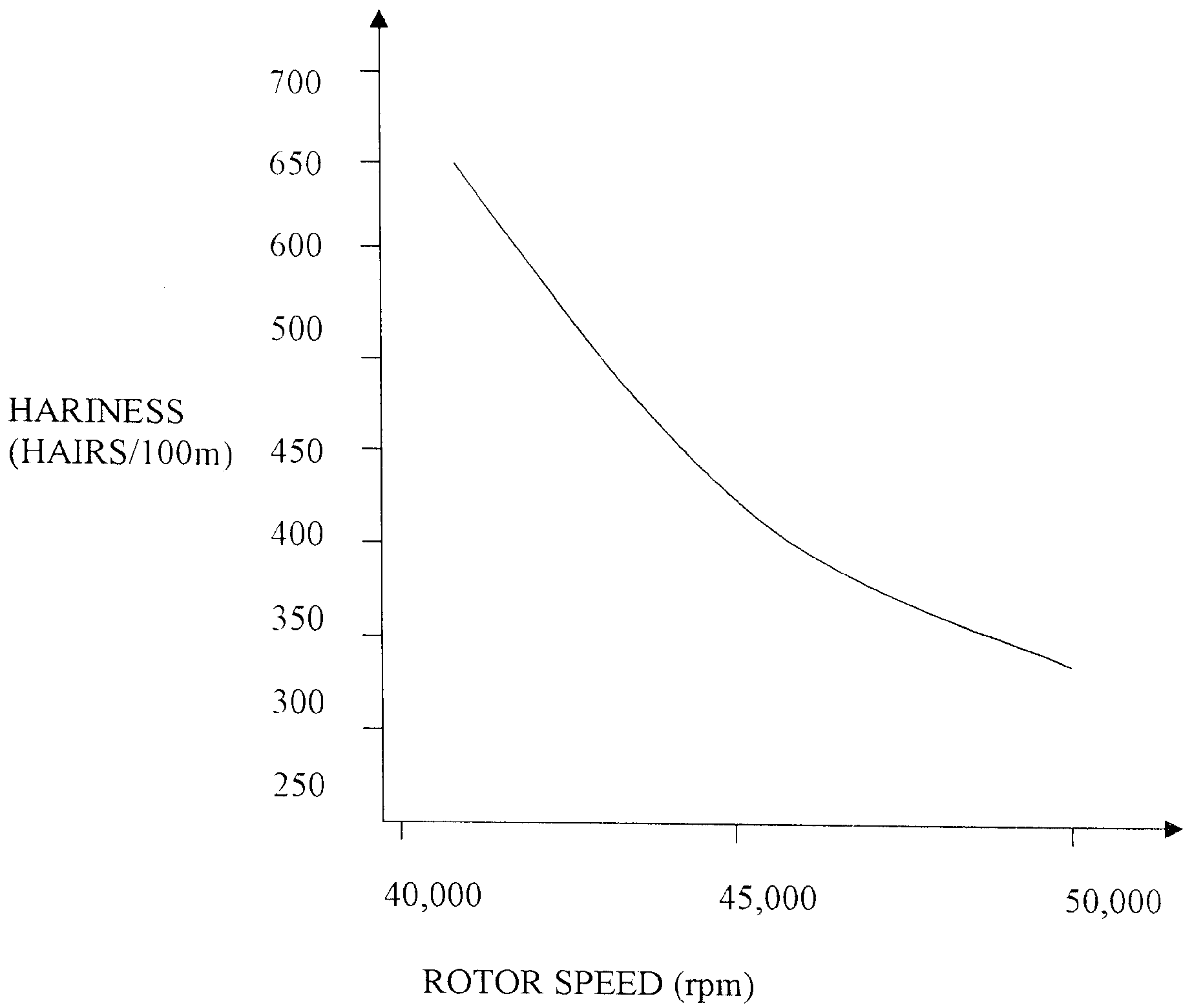

Fig 3

COUNT – 8's Ne

4. ROTOR SPEED Vs. SINGLE YARN STRENGTH

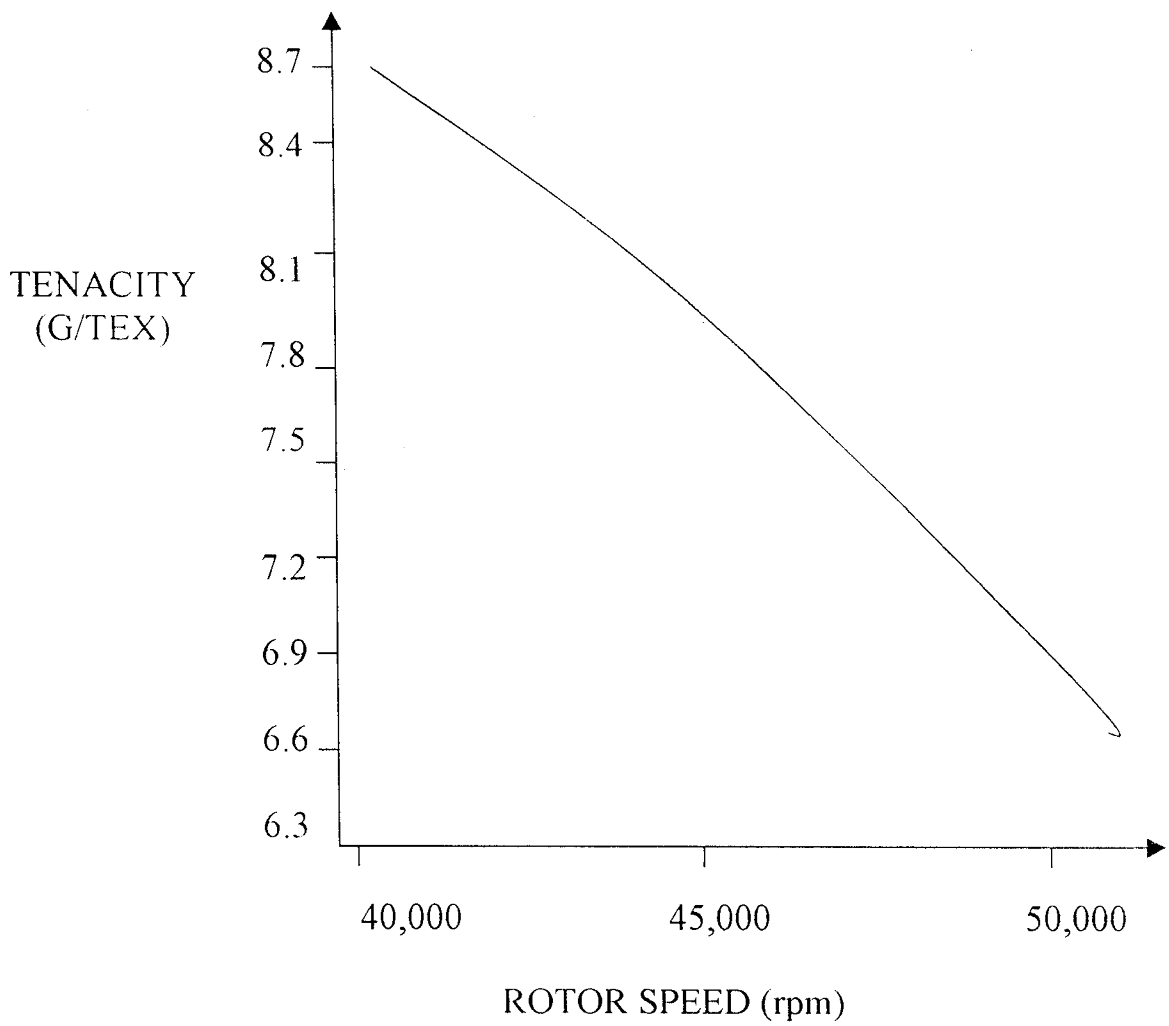

Fig 4

COUNT – 8's Ne

5. OPENING ROLLER SPEED Vs. LEA STRENGTH

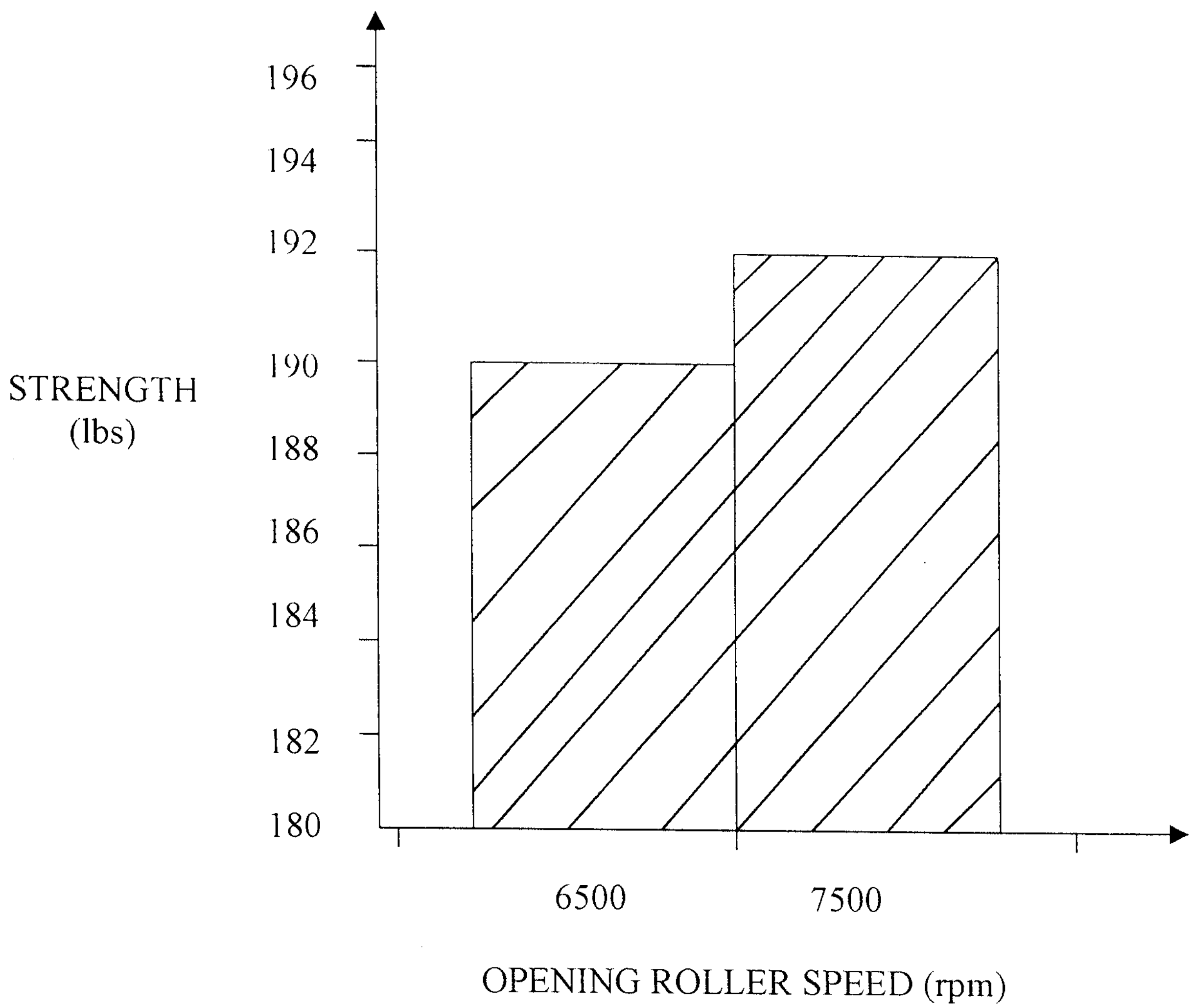

Fig 5

COUNT – 8's Ne

6. OPENING ROLLER SPEED Vs. UNEVENNESS

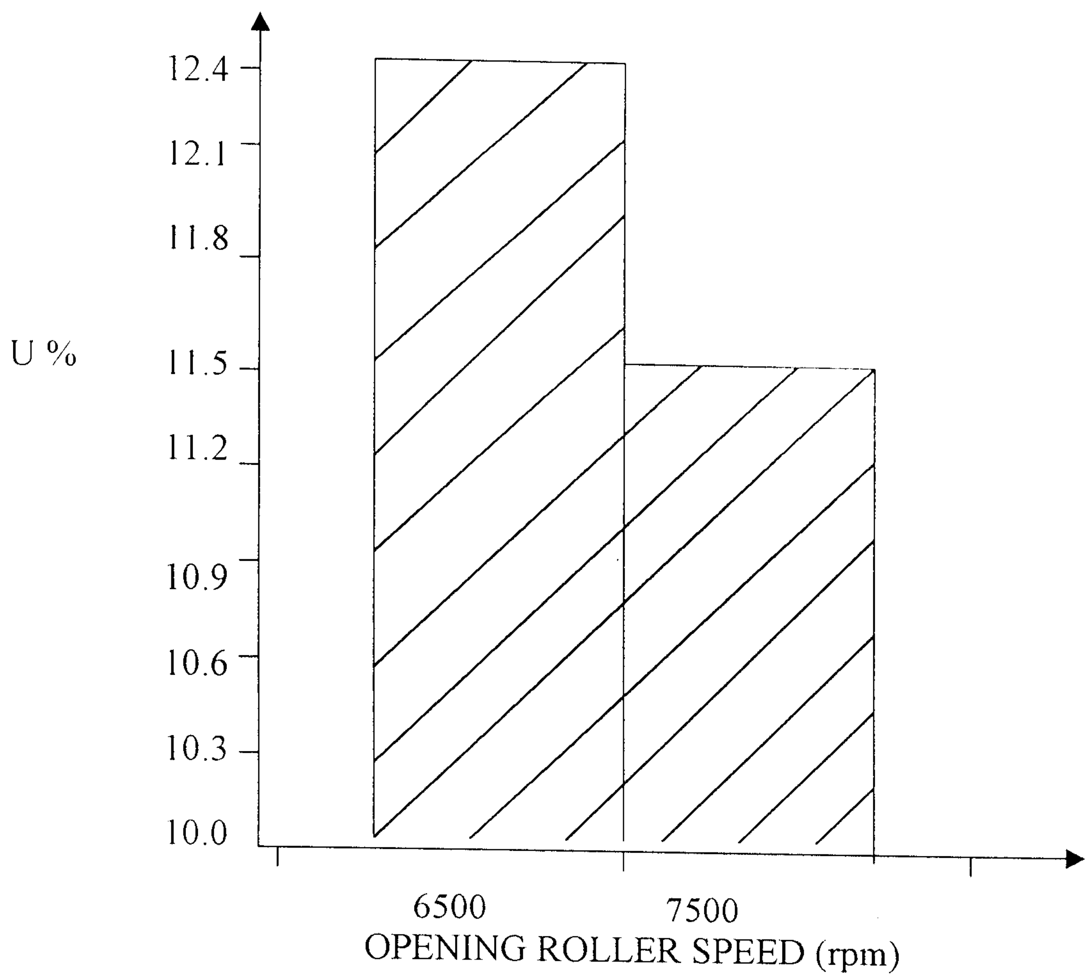

Fig 6

COUNT – 8's Ne

9.ROTOR SPEED Vs. TOTAL IMPPERFECTIONS

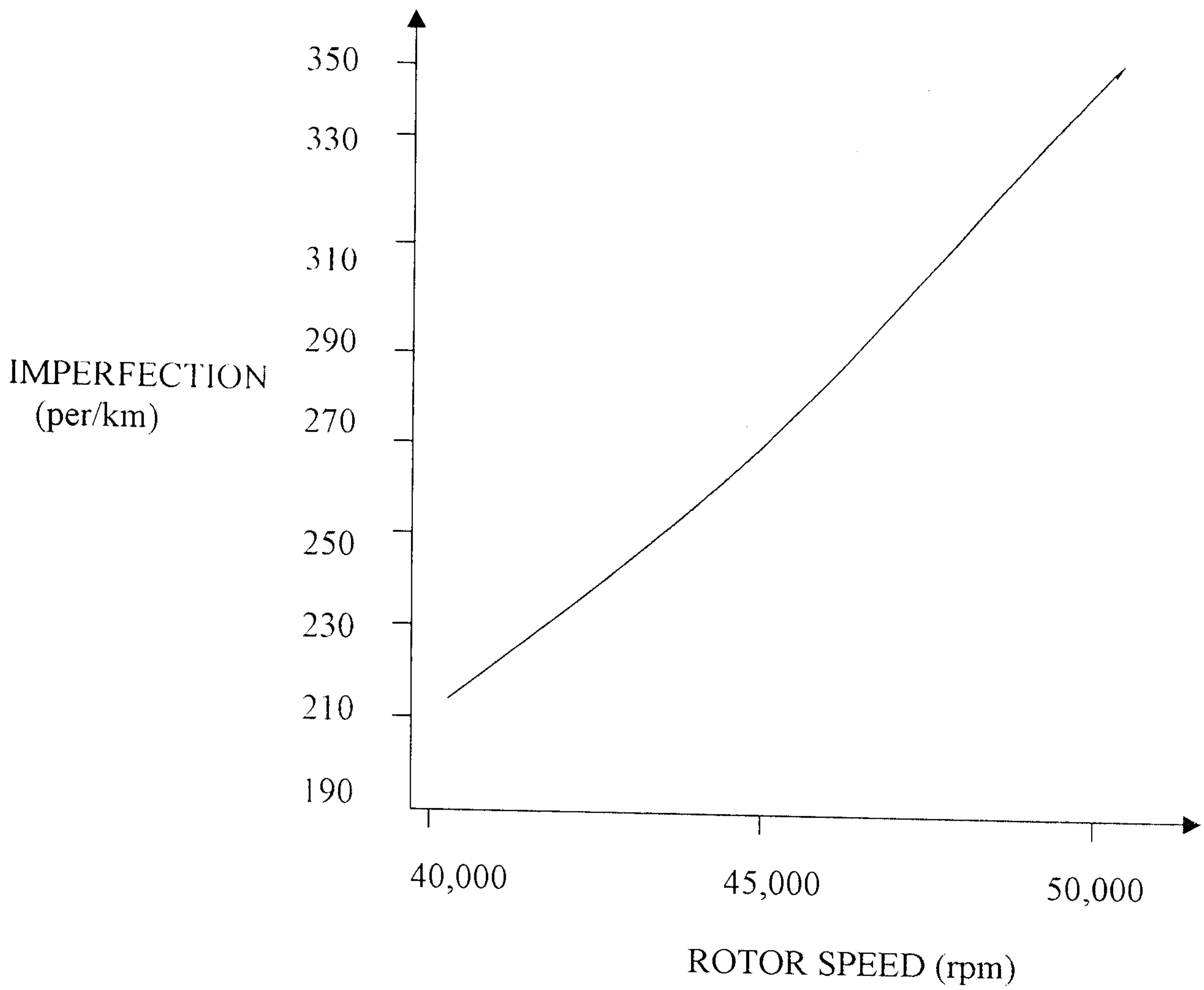

Fig 9

COUNT – 8's Ne

10.OPENING ROLLER SPEED Vs. LEA CSP

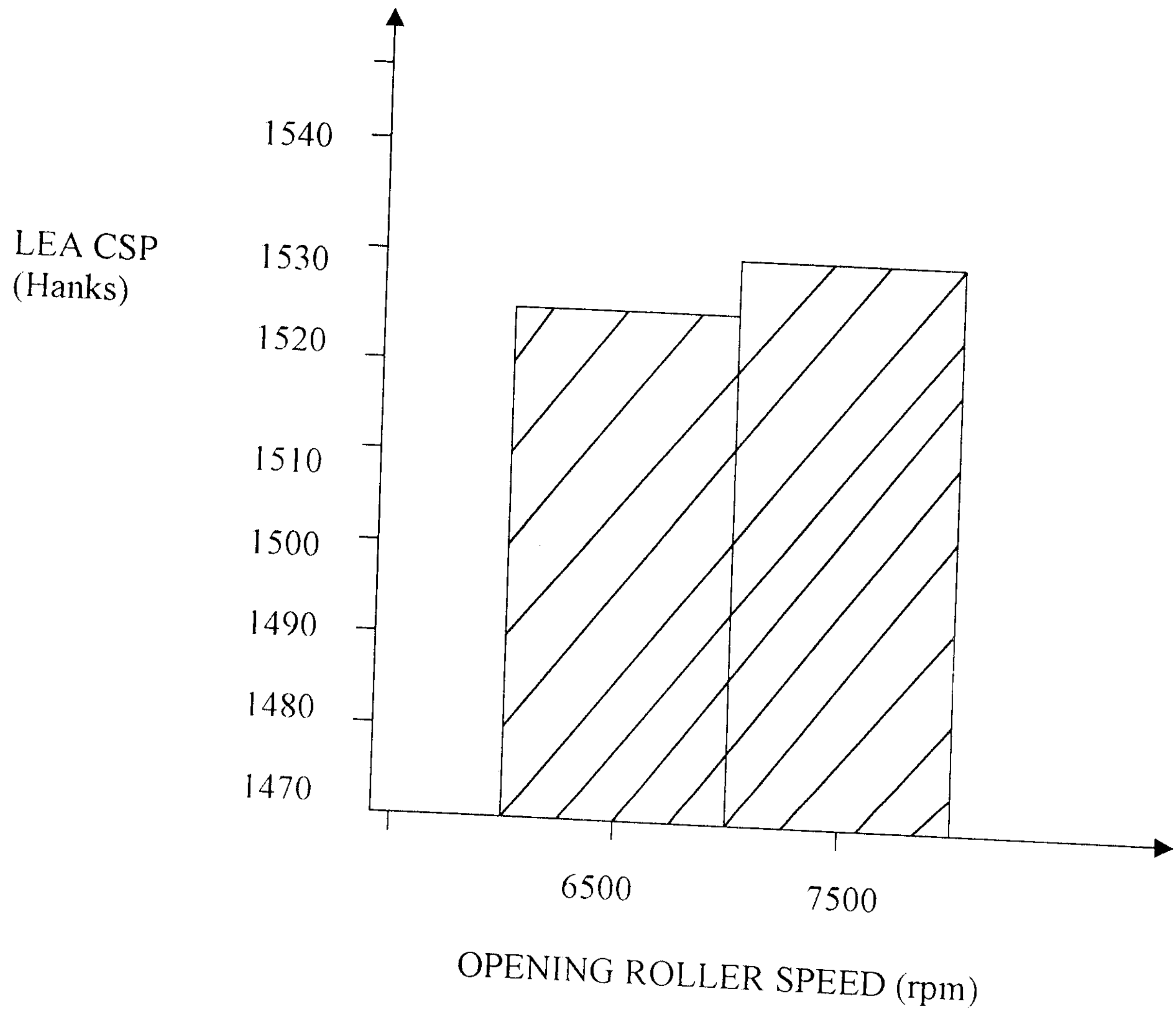

Fig 10

COUNT – 8's Ne

11.OPENING ROLLER SPEED Vs. TOTAL IMPERFECTIONS

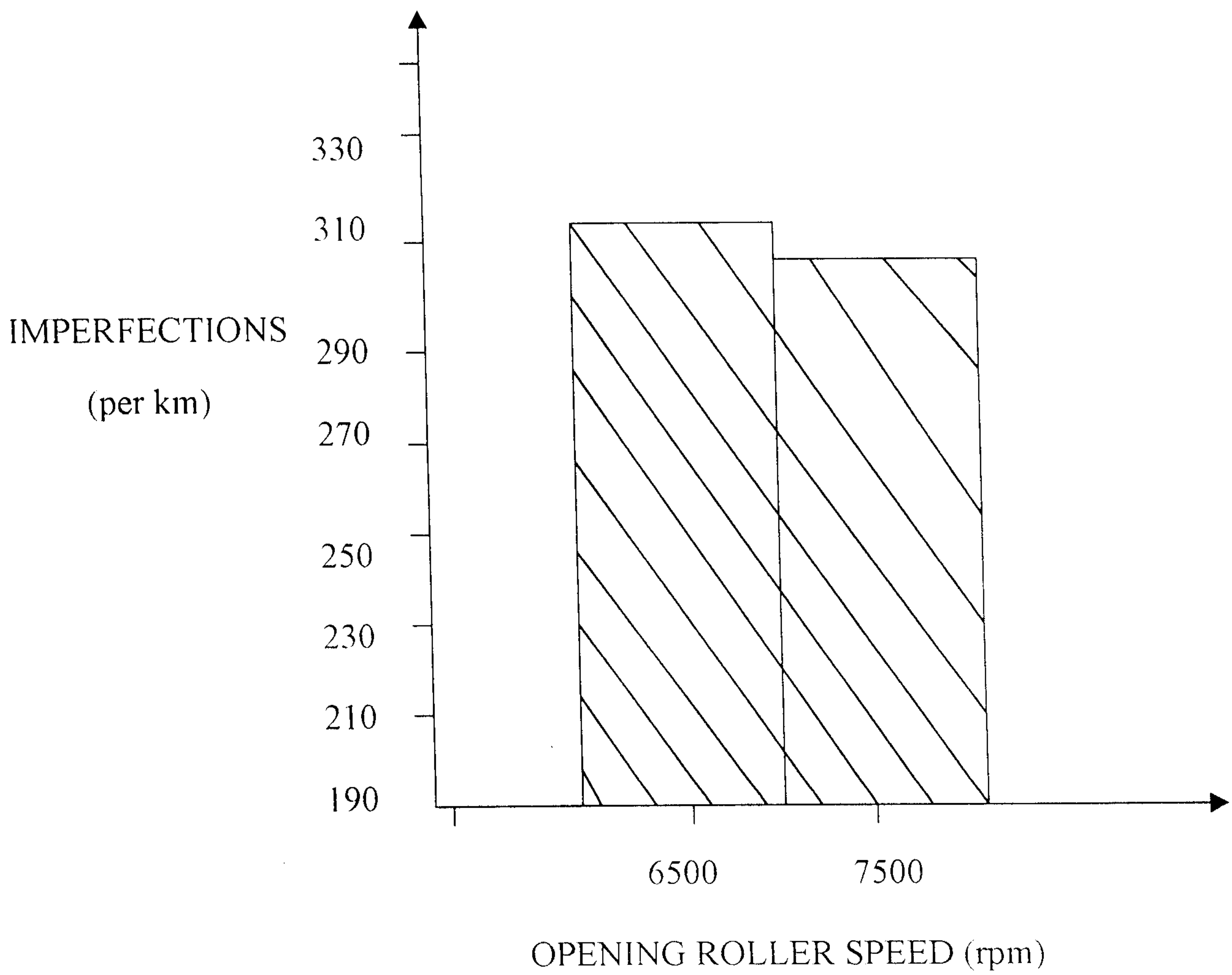

Fig 11

COUNT – 8's Ne

12.SEPARATE ANGLE Vs. LEA STRENGTH

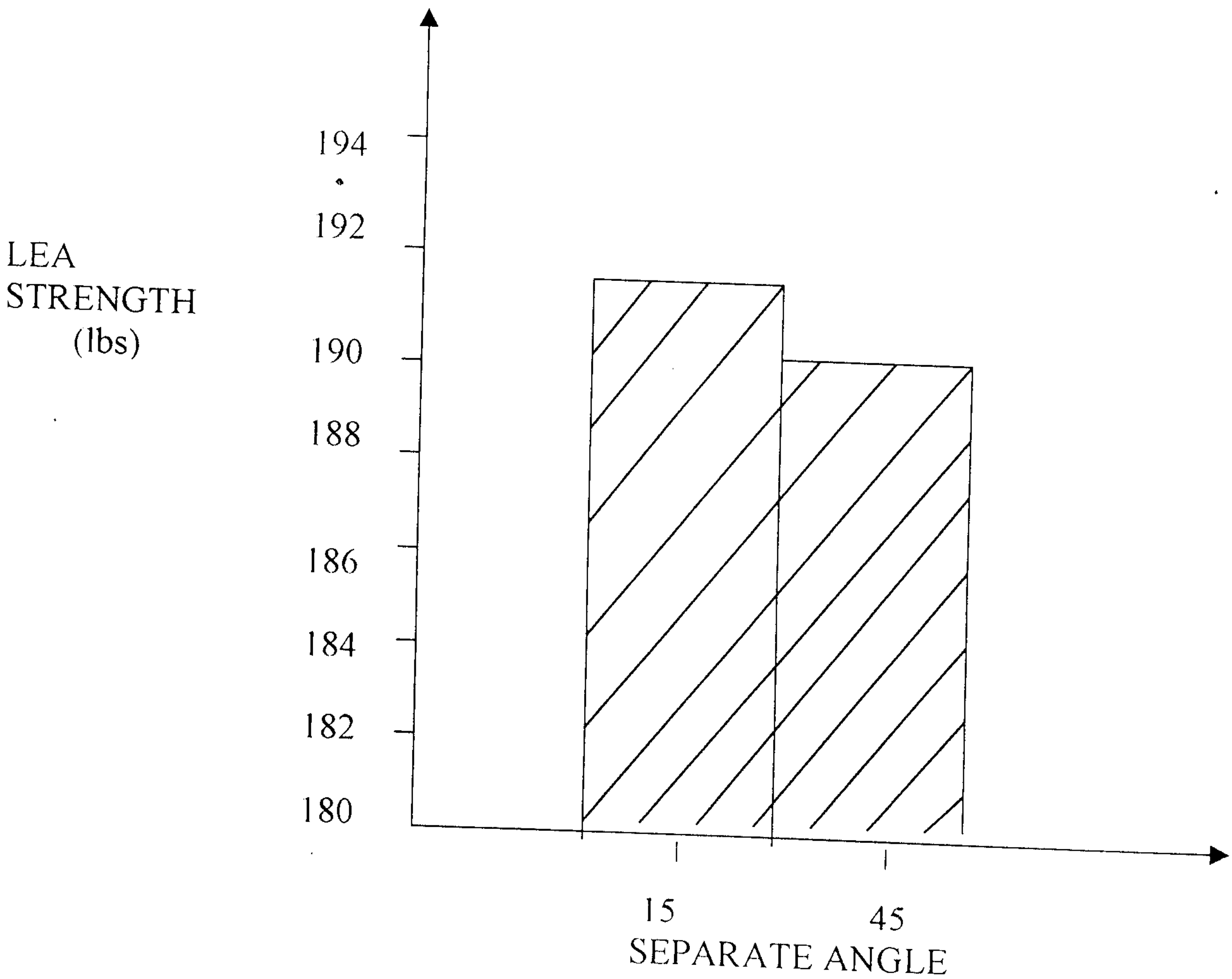

Fig 12

COUNT – 12's Ne

1. ROTOR SPEED Vs. LEA STRENGTH

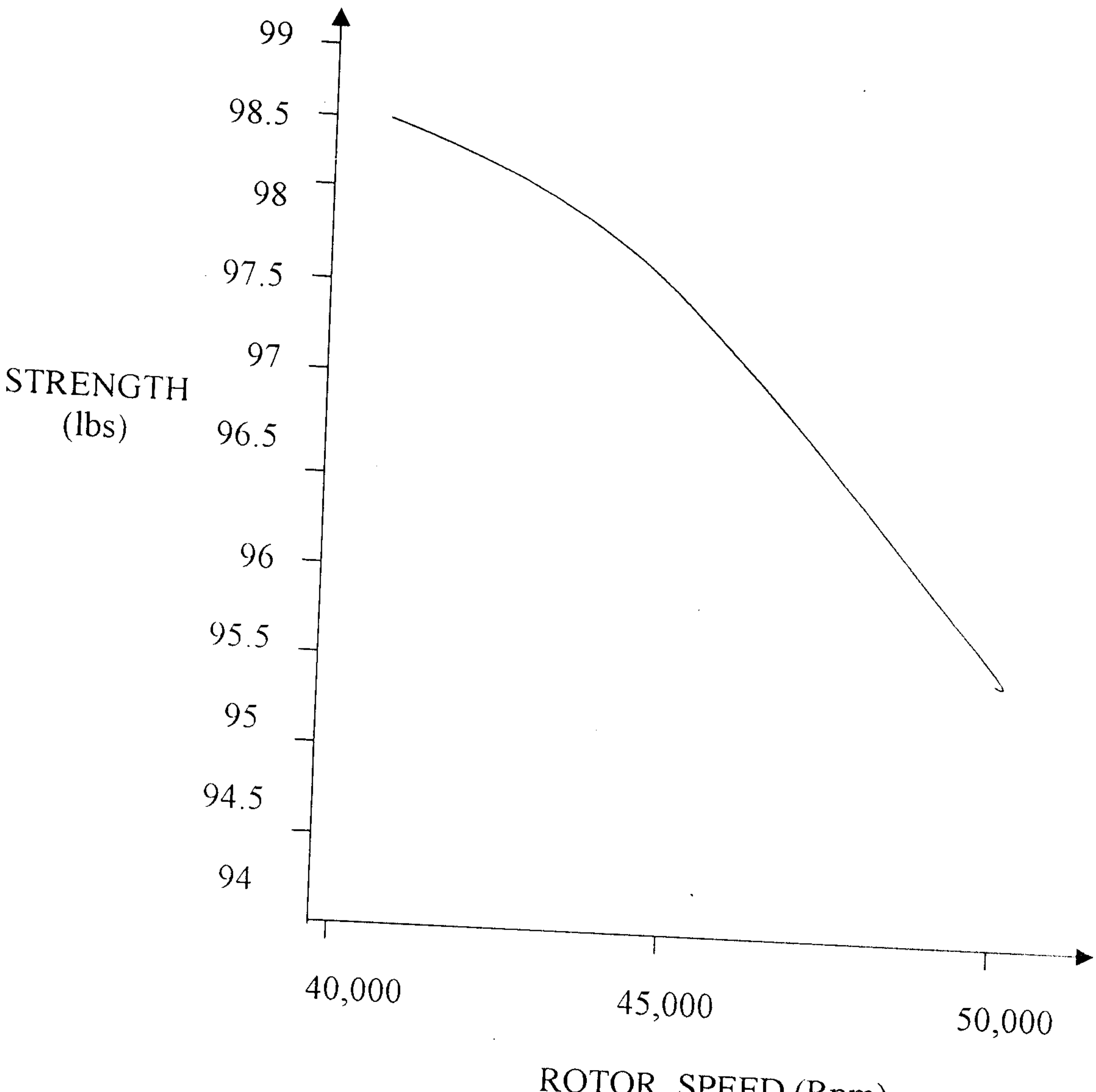

Fig 1

COUNT – 12's Ne

2. ROTOR SPEED Vs. UNEVENNESS

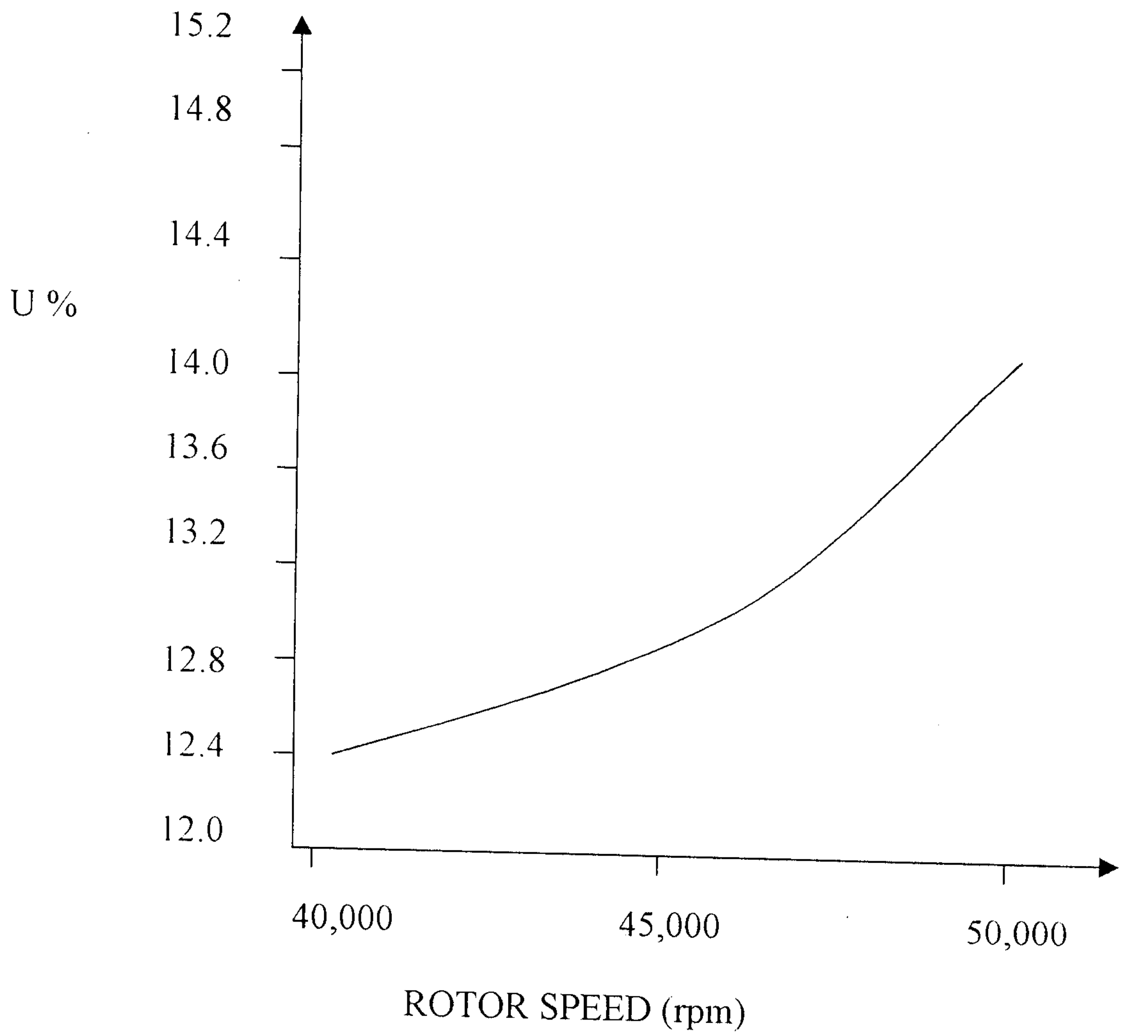

Fig 2

COUNT – 12's Ne

3. ROTOR SPEED Vs. HAIRINESS

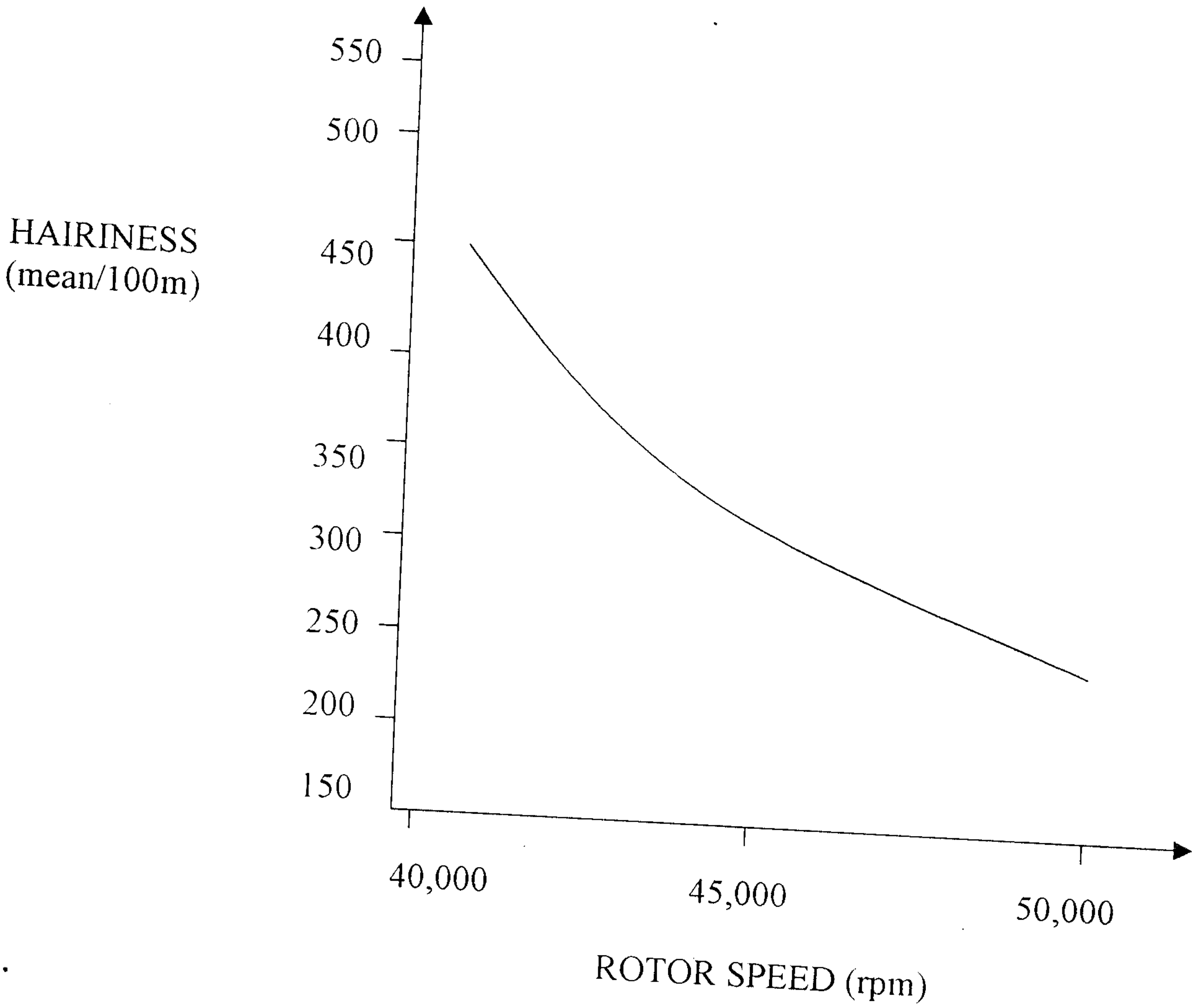

Fig 3

Fig 6

COUNT – 12's Ne

11.ROTOR SPEED Vs. LEA STRENGTH

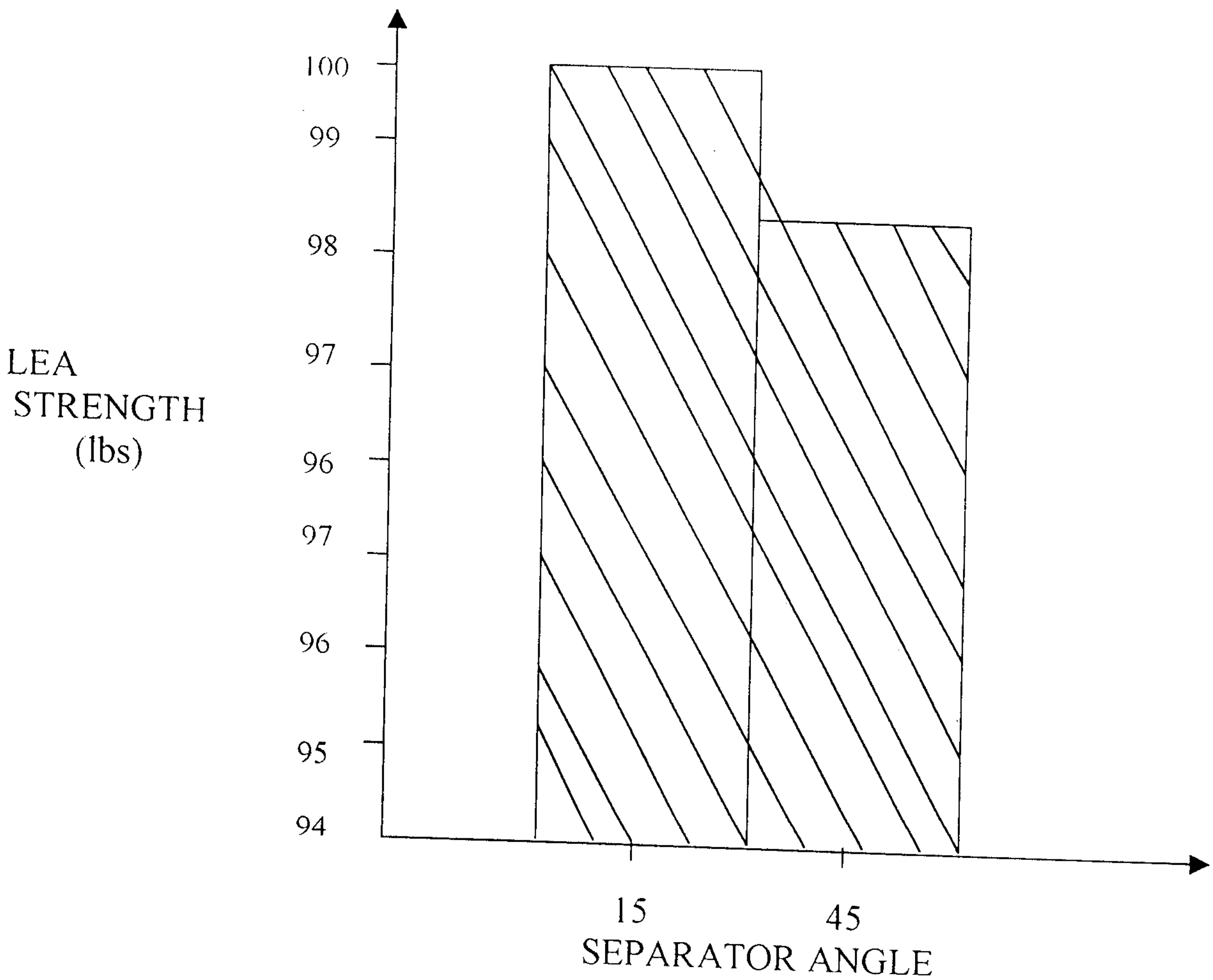

Fig 11

COUNT – 12's Ne

12.SEPARATOR ANGLE Vs. IMPERFECTIONS

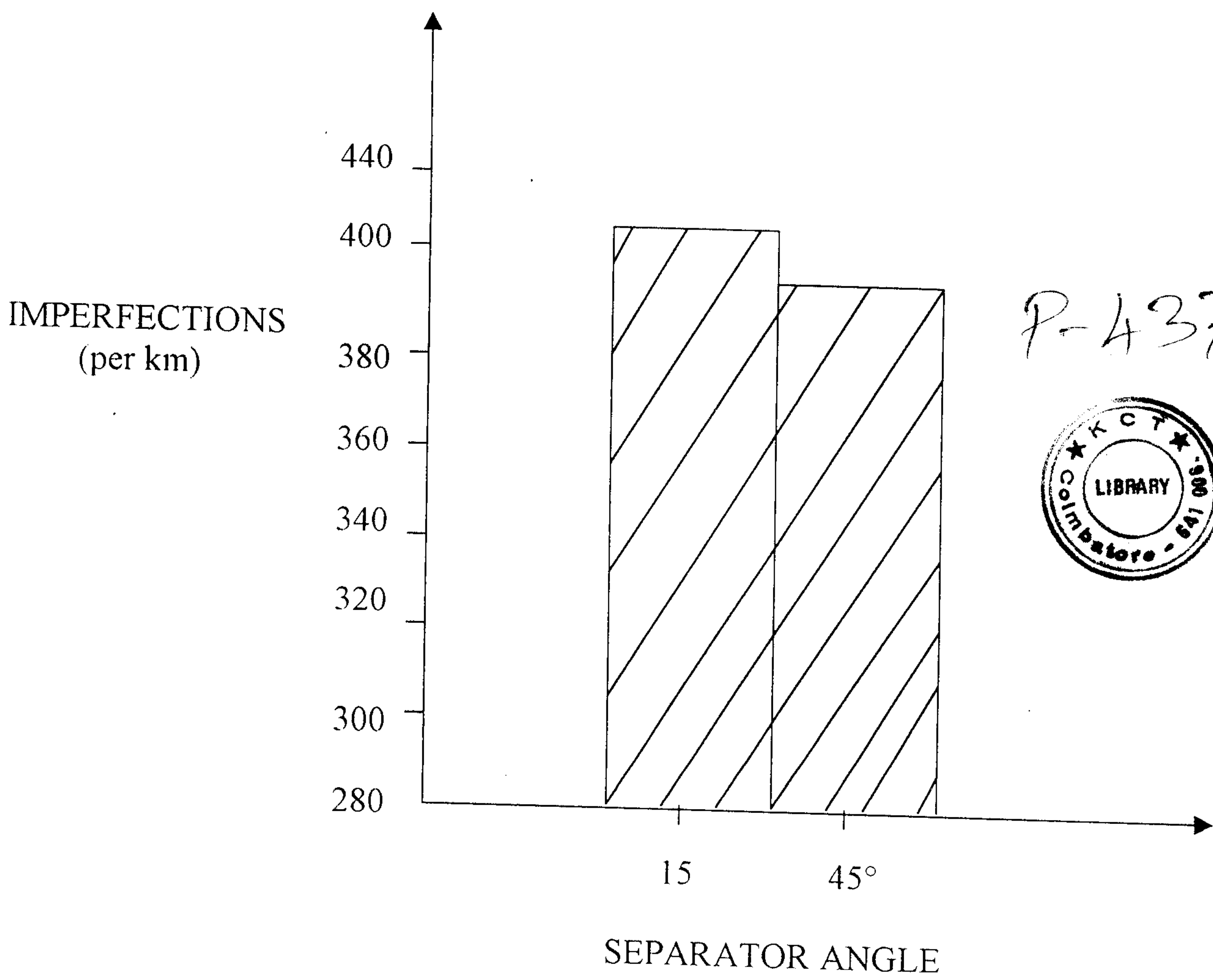

Fig 12