STUDY OF YARN QUALITY USING AIR JET NOZZLE IN RING SPINNING SYSTEM

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BONAFIDE CERTIFICATE

Certified that this project report titled "STUDY OF YARN QUALITY USING AIRJET NOZZLE IN RING SPINNING SYSTEM" is the bonafide work of Mr.J.Sreenivasan who carried out the research under my supervision. Certified further, that to the best of my knowledge the work reported herein does not form part of any other project report or dissertation on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate.

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ABSTRACT

The work described in this report involves an experimental study of Air jet nozzles in ring spinning system.

The insertion of Air jet nozzle in between the lappet and the front roller nip would tend to increase the yarn tenacity and reduce yarn hairiness. This new spinning technique incorporates features of both ring and Air jet spinning system. The air is given a swirling movement through the angled nozzle which creates a shuffling of fibres thereby increasing the compaticity and reducing the yarn hairiness. The pressure is maintained around 5 PSI which is much lower than the pressure used in Air jet spinning.

Based on these factors, four nozzles are designed and 20^s Ne yarn are produced and tested with varying nozzle angles, nozzle orifice dia, twist chamber dia and their positioning. The Air jet ring spun yarns are compared with that of the yarn spun without nozzles in Ring frame for the same count.

As the nozzle orifice angle (Horizontal / Vertical) is increased, Hairiness value gets reduced. The reduction in Twist chamber diameter increases the yarn Tenacity. The performance of nozzle shows a better improvement on yarn evenness when the nozzles are placed in Top position

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1. INTRODUCTION

American John Thrope invented the ring spinning system in 1828, thus having an age of around 150 years. Hundreds of scientists, engineers and machinery manufacturers have worked diligently for years in this technology and still they continue to improve its performance. In fact, it took almost a century to reach 10-m/sec Traveller speeds in continuous spinning while keeping the number of ends down at the level of acceptance. Traveller burning, spinning speed and various moving parts in the ring frame has brought down the superposition of this technology, even though it has the possibility of spinning the counts ranging from 6^s to 120^s Ne.

Regarding productivity, in addition to machine factors, ring spinning system depends on a host of other related factors such as type, count, twist, strength and quality and various secondary spinning parameters including spinning geometry, spinning tension etc. All the factors described above affects the yarn quality, reduce spinning efficiency and thus affect overall productivity.

The yarns produced in this ring spinning system have a wider fluctuation in the quality-based concepts. These quality concepts are influenced by two major factors viz. Material factor and Machinery factor. These two factors are almost interrelated and the superior yarn quality cannot be achieved without either of these factors.

So far, in considering the ring spinning system. Conventional techniques such as sizing for short staples and two folding for long staples can reduce yarn hairiness. Reducing yarn hairiness in staple spinning is also possible using the latest innovations such as compact spinning, but either higher costs or time consumption lessen the effectiveness of the process.

The hairiness is the property, which affects the appearance of yarns and fabrics. It influences the handle, thermal insulation and other apparel characteristics. Excess hairiness also affects the efficiency of knitting and hairiness is a great disadvantage for warp yarns because it induces their tendency to cling and thus causes end breakages. Excessive hairiness causes fly formation in the spinning mill. This causes frequent machine breakdowns; produce poor quality and faulty yarns. The reduction in yarn hairiness should be carried out at low costs. Hence as a low dost process means, introduction of air jet below spinning triangle in conventional ring spinning reduces the yarn hairiness thereby increasing the quality of yarn.

In traditional air jet spinning, the resulting yarn is given a false twist by the revolution of compressed stream of air, which turns at speeds that would be impossible with mechanical twisters. Although this method offers much higher production rates that ring spinning, there are some drawbacks in the resulting yarn because of yarn forming mechanism including properties such as yarn harshness, oriented hairs and others. For yarns spun from 100%, there is the major disadvantage of unacceptably low strength. But considering the positive aspects of this system, the short fibres are folded up in the twisting region thereby making the fibre intact into the yarn. The fibres are rounded up and the fibre extent is decreased. This causes the reduction in yarn strength.

But when considering the fibre extent and their positioning in ring spinning system, the fibres are almost laid parallel so that they all have the equal chance of taking part in the yarn strength.

So considering the above-mentioned factors, the disadvantage of ring spinning and air jet spinning could be eliminated if air jet nozzle is incorporated in the ring spinning system.

2. LITERATURE SURVEY

2.1 Effect of fibre and yarn factors on hairiness of cotton yarns:

K P R Pillay (TRJ, 1994) studied the effect of fibre and yarn factors affecting the hairiness of yarn cottons yarns. He studied the effect of fibre and yarn factors affecting the yarn hairiness. He studied the effect of fibre length, fibre fineness and proportion of fibre ends protruding from the yarn surface using tracer yarns. He studied the effect of yarn twist on the length and proportion of projecting fibre ends and found out the relation between fibre length and length of protruding ends within different length groups of cotton.

While finding out the relation between fibre property and yarn hairiness, he found that total correlation coefficients for mean fibre length, fineness, torsional rigidity and flexural rigidity are highly significant where as fibre strength is significant at 1.2" gauge length. When considering the relation between fibre property and number of protruding ends per unit length, he noticed that the total correlation coefficients for flexural rigidity and fibre weight per unit length are highly significant at 1% level where as torsional rigidity; fibre strength and short fibre % are significant at 5% level.

Also while studying the relation between fibre property and length of ends and loops be noticed that, in general, the length of the fibre end decreases with increase in mean length and decrease in fibre weight of the cotton.

He also found that contribution of protruding ends to the hairiness varied from 26% to 41% and the contribution of loops varied from 58% to 67%. He concluded that with the control of loops, hairiness of yarns may be brought in control.

K P S Pillay also studied the relation between yarn twist and hairiness. He found that as the twist in the yarn increases, hairiness decreases. The number of loops shows a steady decrease with increase in twist.

While studying out the relation between yarn diameter and hairiness, a positive correlation between the number of projecting fibres and yarn diameter was obtained. This confirms the result obtained by Barella.

Protruding loops account for about 2/3 and protruding ends about 1/3 of the hairiness of yarn. It is evident that control of loops is more important factor in controlling yarn hairiness.

For the same cotton, yarn hairiness was found to increase with count when other spinning factors are kept constant.

The preferential protrusion of fibre ends during spinning of blends is a real effect governed to a large extent by the relative mean length and fineness of the different components and by the twist in yarns.

The effect of increase in mean fibre length of cotton is to cut down marketedly the content of the longer fibres in the surface hairiness zone.

The majority of fibre ends projecting from the yarn surface are the trailing ends of fibres.

2.2 Process to control hairiness in yarns:

A R Kalyanaraman (JTI, 1992), has framed out a process to control hairiness in yarns. He carried out a preliminary investigation in which fuzziness is reduced by increasing the pressure of air around the point of twisting. Thus he used pressure chamber arranged below the spinning triangle. He concluded that

- By inserting a pressure column between the front roller and lappet and allowing the twisting yarn to pass through this column, the hairiness in the yarn could be considerably reduced.
- Reduction in yarn hairiness appears to be a speed related phenomenon and the re chamber may have a role to play in determining the speed.
- The study reveals that the hairiness is minimal for nominal values of pressure rise and the hairiness increases at low and high pressures.

2.3 Reducing yarn hairiness with Jet ring:

Wang, Miao and How (TRJ, 1997) have carried out the work on reducing yarn hairiness with jet ring. The air pressure applied was 0.5 bar, which is much lower that air pressure used in Air jet spinning. He compared the hairiness by taking the S3 values obtained with Zweigle G565 hairiness meter. They found out 40% reduction in the number of hairs exceeding 3mm (i.e. the S3 value) for the 56 Tex worsted Jet ring spun yarn compared with its ring spun counter part. In addition they found that jet ring spun yarns have a tensile strength equivalent to that of ring spun yarns. They haven't found considerable difference in yarn evenness.

2.4 Effect of an Air Suction nozzle on yarn hairiness and quality:

Boon soo jeon (TRJ,2000) had studied the effect of Air suction nozzle on yarn hairiness and yarn quality. They carried out trials using Air jet suction nozzles

With different hole angles and found out the number of hairs longer than (or) equal to 3mm is reduced by more than 50%. He carried out the experiment by varying the nozzle parameters like orifice dia; nozzle length, angle, position & air pressure and concluded that

- The nozzle size has no significant on hairiness.
- The air pressure through 60^0 hole angle can fold fibre ends efficiently than with 90^0 and 120^0
- The location of suction nozzle close to the yarn outlet may weaken air suction.
- The increase in air pressure has a significant effect on hairiness ie increase in air pressure reduces the hairiness in yarn.
- So far considering the evenness, the nozzle has no significant effect on evenness.

2.5 Yarn quality improvement with an air jet attachment in cone winding:

K.P.Chellamani, D.Chattopadhyay & K Kumarasamy (IJFTR, 2000) has carried out a study on yarn quality improvement with air jet attachment in cone winding. Three different orifice angles (30^0,45^0,60^0) were taken into consideration with three different pressures (0.5 kg/cm^2, 1.0 kg/cm^2, 1.5 kg/cm^2). It has been observed that best results are achieved with air jet nozzle of 60^0-orifice angle and 1.0 kg/cm^2 air pressure. With this nozzle they got a decrease in hairiness by 50 – 75%. Also they found that the yarn imperfections increased by 20 – 35% and unevenness by 0.7% for all the counts they have studied.

2.6 Air and Ring combination in Tandem spinning:

Shawney & Kimmel (TRJ, 1997) have studied the air and ring combination in producing air jet ring spun yarns. Their preliminary investigations showed that a conventionally drafted roving strand, when subjected to air jet spinning action, produces an air-bolstered, partially strengthen fibrous strand, which subsequently requires a relatively low true (ring) twist, for its reinforcement and ultimate conversion into a novel, single component yarn. Since the yarn throughput of the ring spinning is inversely proportional to the yarn twist level, the relatively lower yarn twist is required. They concluded with a result that the air jet ring spun yarn is weaker than the comparable ring spun yarn.

2.7 Jet Ring spinning and its influence on Yarn hairiness:

Cheng and Li (TRJ, 2002) have carried out study on jet ring spinning and its influence on yarn hairiness. They have designed a nozzle in which there are two sub-nozzles I and II, meant for inserting false twist to the ring yarn. They suggested that when an air jet nozzle is incorporated below the front roller nip, allowing the twisting yarn to pass through the nozzle, yarn hairiness can be significantly reduced. This reduction is probably due to the hypothesis that, the yarn structure is loosened first before the yarn enters the nozzle and the subsequent tightening up the structure as the yarn emerges from the nozzle may wrap or tuck protruding fibre ends into the yarn body through a swirling air current induced by the air jet nozzle. Since most of the protruding fibre ends corresponds to trailing ends, it is logical to believe that the axial in vortex spiraling along the yarn in a direction opposite that of the yarn traverse may suppress, rather that promote, these protruding fibre ends. When a wrapper fibre increases beyond certain number, they can be expected to bind the yarn and decrease the protrusion of the fibre ends, leading to reduced hairiness. They have demonstrated that jet ring spun yarns are even superior to conventional ring spun yarns on the basis of yarn breaking force and Tenacity and concluded that the fibre properties play a significant role in influencing the effectiveness of the wrapping action.

2.8 Open end spinning using Air jet twisting:

Chongwen Yu (TRJ, 1999) has carried out study on air jet twisting in open end spinning. Twist in the open end jet spun yarn is inserted by jets of air that are tangential to the twist tube in the twist nozzle and thus form a vortex. This twisting rate was about 2, 00,000 – 3, 00,000 rpm which was impossible with mechanical twisters and so this method have proved a high production potential. He compared the arrangement of fibres in various yarns and are shown in Table:-

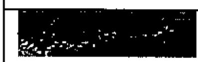
Shape of fiber	Open-end jet	Rotor	DREF	Vortex	Ring
	19	33	12	13	77
	27	22	27	28	10
	15	17	5	12	2
	6	12	4	28	8
	19	12	40	19	3
	15	4	12	-	-

Table 2.1: Arrangement of fibres in various yarns

He concluded that the yarn produced by the open end jet spinning has a structure similar to that of rotor yarn, but the strength of the open end jet spun yarn is inferior to that of rotor spun yarn.

2.9 Numerical and Experimental study on reducing yarn Hairiness:

Zeng and Yu (TRJ, 2004) have carried out a Numerical and Experimental study on reducing yarn hairiness with the jet ring and jet wind. They have investigated the reduction of yarn hairiness both numerically and experimentally. They have developed a two-phase air / fibre model to stimulate the wrapping of protruding surface fibres around the body. They have studied the influence of two of the nozzle parameters – nozzle pressure and jet orifice angle – on yarn hairiness reduction by analyzing computational and experimental results. Their results showed that when using jet ring spinning and jet wind process, hairiness reduction is significant. Though a higher nozzle pressure and smaller orifice angle causes more hairiness reduction, it is not helpful to increase the nozzle pressure to a very high level or to use too small an orifice angle. Accordingly to the simulation, they found that the rational levels of the parameters are a nozzle pressure of 1.5 – 2.5 bar and a jet orifice angle of 40^0 -50^0.

2.10 Numerical simulation of Air flow in the Air jet nozzle:

In addition Zeng and Yu (TRJ, 2003) have made a Numerical simulation of airflow in the nozzle of an air jet spinning machine. A CFD (Computational Fluid Dynamics) model has been developed to stimulate the air flow patterns inside the nozzle of an air jet spinning machine. The design parameters of the nozzle are related to the flow characteristics. Three parameters are discussed viz. Nozzle pressure, Jet orifice angle and Jet orifice position.

The effect of nozzle pressure was significant with increasing nozzle pressure, both the axial and tangential velocity in the nozzle increases, thus increasing the tensile property of yarn. However it was not sensible to increase nozzle parameters to a very high level. The jet orifice angle affected the flow characteristics in a complex way. It affected axial velocity and negative pressure at the inlet.

The influence of the jet orifice position on the flow structure was found to be insignificant. Their computation simulation has proved a useful insight into

nozzle flow behavior and has demonstrated that CFD can be used to optimize the design of the nozzle to produce better yarns.

2.11 Design and development of twin Air jet nozzle for Ring spinning:

K Ramachandrulu & V Ramesh (NCIE, 2002) have designed and developed twin Air jet nozzle for ring spinning and evaluated the influence of twin Air jet nozzle on the quality of ring spun yarn under different air pressure combinations in the two nozzles. They concluded that

a) In general twin air jet nozzle arrangement was found to contribute to the improvement of tenacity and yarn quality index under different pressure combinations of air administered in the 'S' and 'Z' nozzles.

b) In general it was found that the structure of yarn undergoes compaction exhibiting increase in tenacity and packing factor with air jet nozzle system.

c) In particular the twin air jet nozzle arrangement is found to produce the best results with 0.25 / 0.5 bar air pressure combination in 'S' and 'Z' nozzle showing 17.5% increase in yarn tenacity and 18.5% improvement in yarn quality index.

d) In particular the air pressure combination of 0.25 / 0.5 bar in S and Z nozzle was found to condense the yarn to the maximum extent with 15% increase in packing factor.

3. RESEARCH OBJECTIVE

- To design the Air jet nozzle for ring spinning system.
- To Fabricate the Air jet nozzle in ring spinning.
- To produce the Air jet ring spun yarn in Tandem spinning.
- To evaluate the influence of Air jet nozzle position and parameters on the quality of the so produced yarn.

4. MATERIAL AND METHODS

4.1 Introduction:

To carry the study on quality of Air jet ring spun yarn, certain methods are needed to be formulated. The method involves the nozzle material, their production and the process material namely the cotton.

4.2 Designing of Air jet nozzle:

The principle based on which the Air jet nozzle functions is shown in fig 4.1

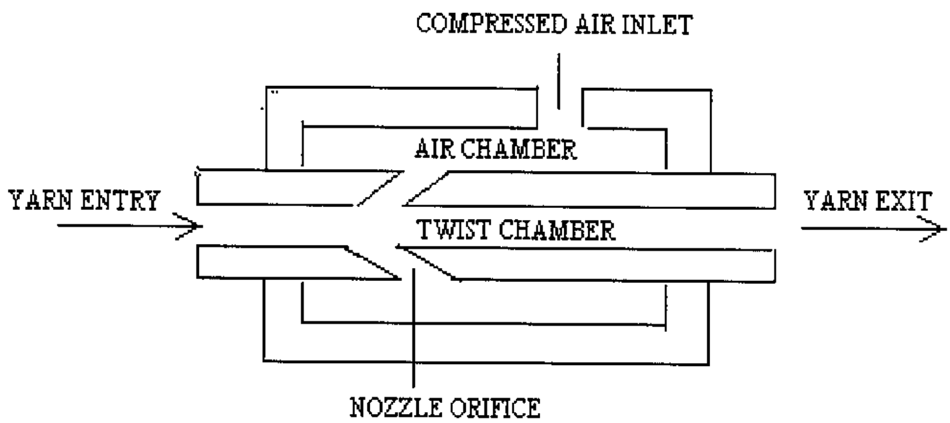


Figure 4.1 Basic principle of Air jet nozzle

The Assembly consists of two main parts viz.

a) Nozzle and

b) Housing unit.

4.2.1 Nozzle:

Nozzle is the main part which is made of brass rod of 8mm dia. The function of nozzle is to shuffle the fibres when a compressed air is flown through the orifice, thereby inducing compactness to the yarn. The main parameters to be considered in nozzle are:

a) Horizontal angle.

b) Vertical angle.

c) Twist chamber diameter and

d) Orifice diameter.

A basic nozzle unit is shown in fig 4.2

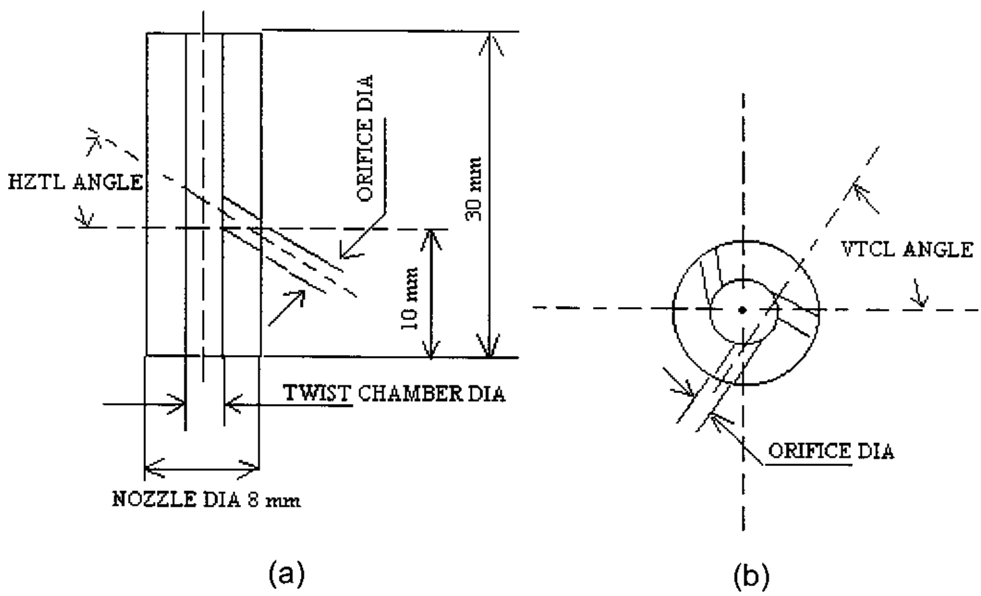


Figure 4.2 Nozzle (a) Front view; (b) Plan

4.2.2 Housing unit:

This forms the outer chamber for nozzles in which the nozzle gets seated. The housing unit consists of an air chamber drilled inside, so that it paves a way for compressed air to pass through the nozzle orifices. A typical housing unit is shown in fig 4.3

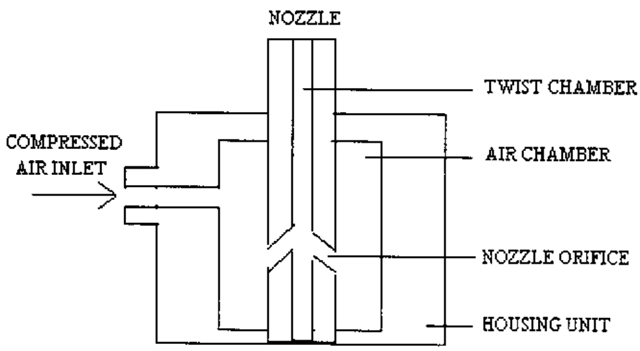


Figure 4.3 Housing unit

4.3 Design aspects of Air jet nozzle:

The nozzle taken is the 'Z' direction nozzle which is particularly meant for 'Z' twist yarns. The main varying parameters of the nozzle are:

a) Horizontal angle

b) Vertical angle

c) Twist chamber dia and

d) Orifice dia

Two values are given for each parameter and four nozzles are designed as

Nozzle = Hztl angle / Vtcl angle / Twist chamber dia / orifice dia

N1 = $27^0 30'$ / 70^0 / 4mm / 1mm

N2 = 25^0 / 70^0 / 4mm / 1mm

N3 = $27^0 30'$ / 75^0 / 3mm / 1mm

N4 = $27^0 30'$ / 80^0 / 3mm / 1.5mm

In addition to these four types of nozzles positioning of nozzles were also considered. Hence two positions Top and Bottom are considered where the nozzle assembly is placed at 75mm and 115mm from the front roller nip. Totally 8 samples were taken with nozzle and 1 sample is taken without nozzle.

4.4 Functioning of the nozzle:

The nozzle assembly along with housing unit is placed in between front roller nip and lappet as shown in fig 4.4

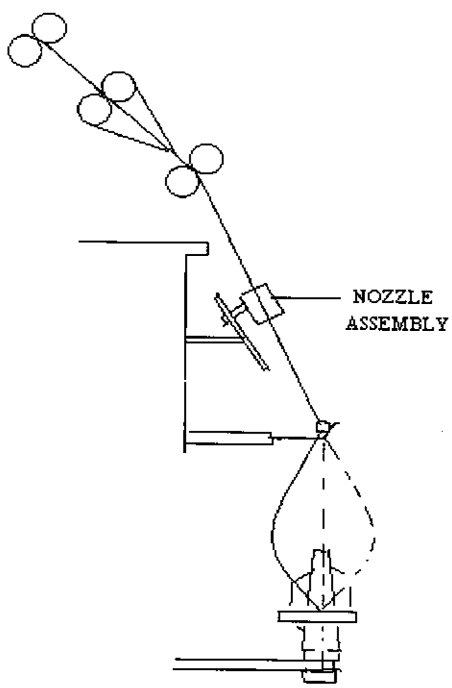


Figure 4.4 Arrangement of Air jet nozzle in Ring frame.

The compressed air of around 5 psi is fed on to the chamber through 8mm hose. The Air chamber inside the housing unit provides a room for the nozzle. The air gets a swirling movement with the effect from the bi-directional orifice angles.

The swirling air imparts a false twist to the so formed yarn thereby shuffles the fibres. This causes as increased fibre intact thereby allowing the short fibres to get into the core of the yarn.

4.5 Process parameters:

Fibre property:

Fibre type	= cotton.
Roving hank	= 1.35.
Mixing	= 30^s mixing.

Machine parameters:

Make	= Trytex, Coimbatore.
Machine speed	= 12000 rpm
Yarn count	= 20^s Ne.
Twist multiplier	= 4.2
Twist per inch	= 16.99
Break draft	= 1.2
Twist direction	= 'Z'
Spinning angle	= 10^0
Drafting angle	= 45^0
Yarn contraction	= 2.9
Drafting system	= Suessen WST Drafting system
Traveller number	= 4/0.

A linear density of 29.52 Tex of the yarn was produced in the ring frame fitted with Air jet nozzle.

4.6 Yarn testing:

Four nozzles were designed and positioned in two positions 75mm and 115mm from the front roller nip. Totally 8 samples were taken with nozzles and their quality is compared with the yarn of equivalent count spun without Air jet nozzle. The yarn qualities taken into consideration are:

a) Yarn count and its CV%

b) Zweigle yarn hairiness (S3 Value)

c) Zweigle hairiness index

d) Uster Hairiness index

e) U % and imperfections

f) Single yarn strength

g) TPI.

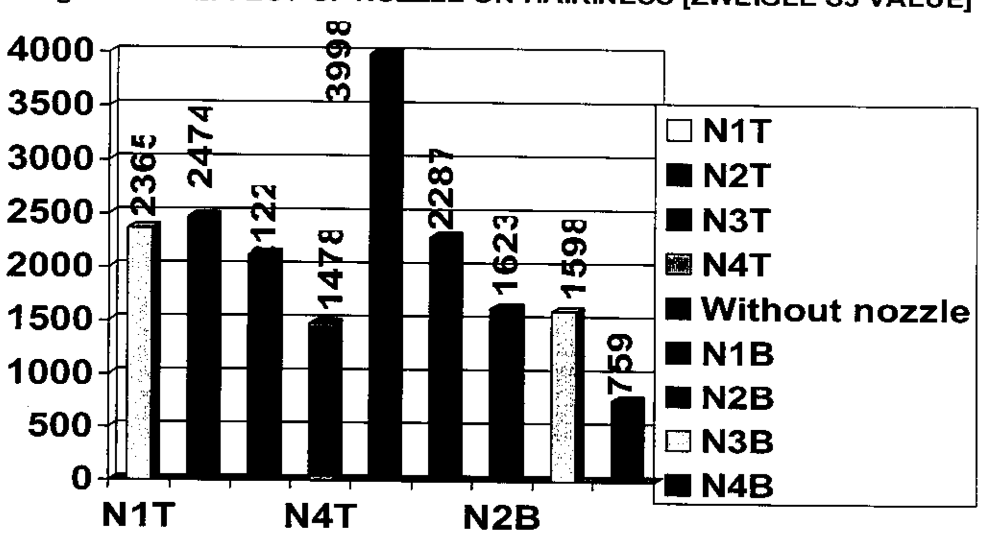
5. RESULTS AND DISCUSSION

The Air jet ring spun yarns are produced with four nozzles positioned in top and bottom position and the properties are compared with that of the same count spun without Air jet nozzle. The effects of nozzle on different properties are studied and the effects of each parameter in nozzle reflecting the property of yarn are also studied.

5.1 Effect of Nozzle on Zweigle Hairiness [S3 Value]:

Figure 5.1 demonstrates the effect of nozzle on S3 value of Zweigle hairiness.

Figure 5.1 EFFECT OF NOZZLE ON HAIRINESS [ZWEIGLE S3 VALUE]

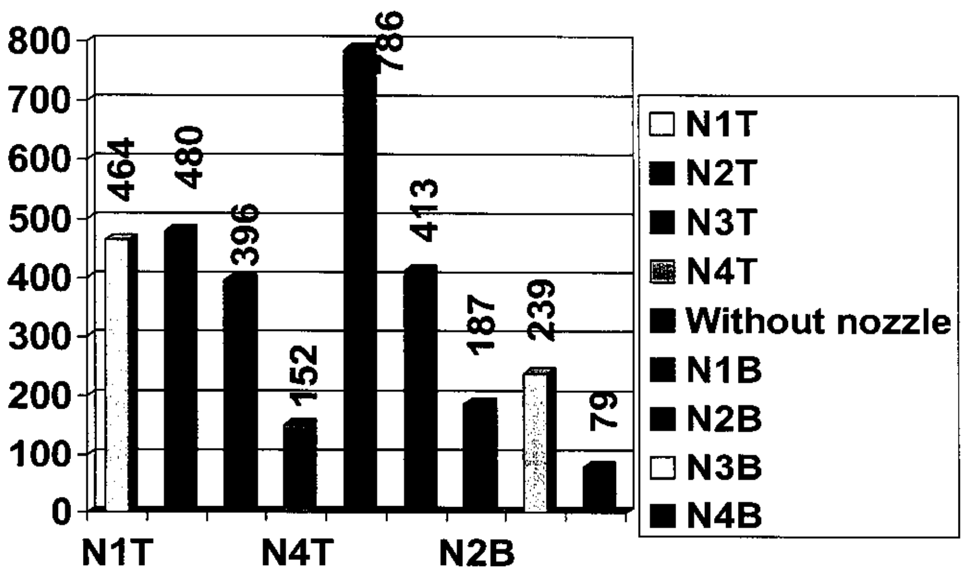


- The nozzles have shown a predominant decrease in S3 Hairiness value. The percentage decrease varies from 38% to 81%.
- Nozzle N1 shows 41% and 43% decrease in Zweigle S3 hairiness value in Top and Bottom positions.
- Nozzle N2 shows 38% and 59% decrease in Zweigle S3 hairiness value in Top and Bottom positions.
- Nozzle N3 shows 47% and 60% decrease in Zweigle S3 hairiness value in Top and Bottom positions.
- Nozzle N4 shows 63% and 81% decrease in Zweigle S3 hairiness value in Top and Bottom positions.

5.2 Effect of Nozzle on Zweigle Hairiness Index:

The effect of nozzle on Zweigle hairiness index is shown in Figure 5.2

Figure 5.2 EFFECT OF NOZZLE ON HAIRINESS INDEX [ZWEIGLE]

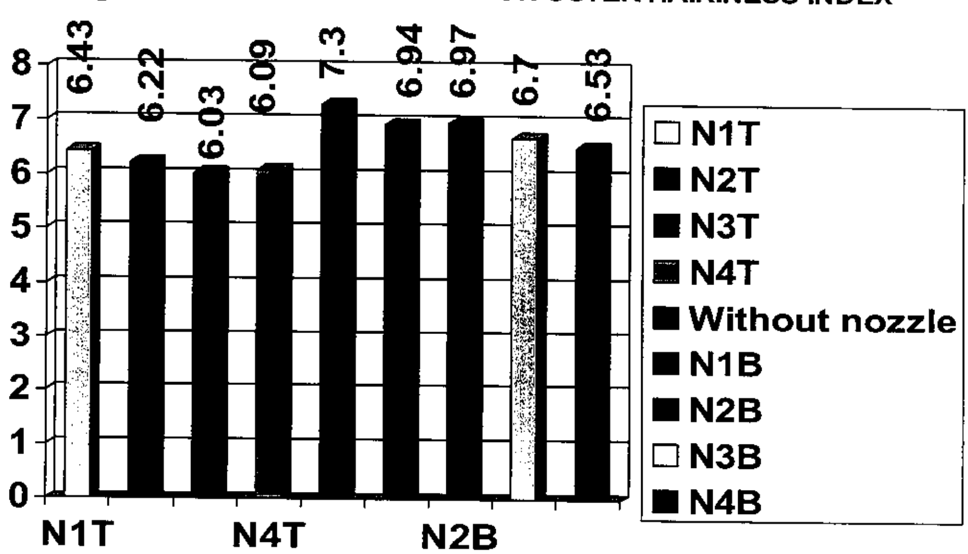


- Hairiness index value gets reduced drastically in the range between 39% to 90%.
- Nozzle N1 shows 41% and 47% decrease in Zweigle hairiness index value in Top and Bottom positions.
- Nozzle N2 shows 39% and 76% decrease in Zweigle hairiness index value in Top and Bottom positions.
- Nozzle N3 shows 50% and 70% decrease in Zweigle hairiness index value in Top and Bottom positions.
- Nozzle N4 shows 81% and 90% decrease in Zweigle hairiness index value in Top and Bottom positions.
- A steep decrease is observed in nozzle N2 & N3 when their positions are changed from top to bottom.

5.3 Effect of Nozzle on Uster Hairiness Index:

Figure 5.3 shows the effect of nozzle on uster hairiness index,

Figure 5.3 EFFECT OF NOZZLE ON USTER HAIRINESS INDEX

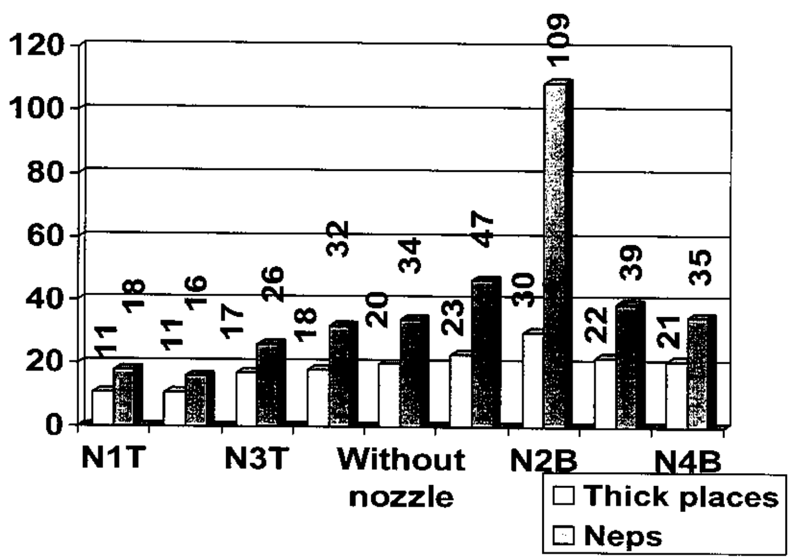


- The nozzle does not have a pronounced effect on uster hairiness index, but has a slight improvement in the index value.
- The behavior of nozzles are more superior in top position than in bottom position.
- Nozzle N1 shows 12% reduction in index value in top position as against 5% reduction in bottom position.
- Nozzle N2 shows 15% and 5% reduction in the index value in top and bottom position.
- Nozzle N3 shows 17% and 8% reduction in the index value in top and bottom position.
- Nozzle N4 shows 17% reduction in index value in top position as against 11% reduction in bottom position.

5.4 Effect of Nozzle on Imperfections:

The effect of nozzle on imperfections is shown in Figure 5.4

Figure 5.4 EFFECT OF NOZZLE ON IMPERFECTIONS

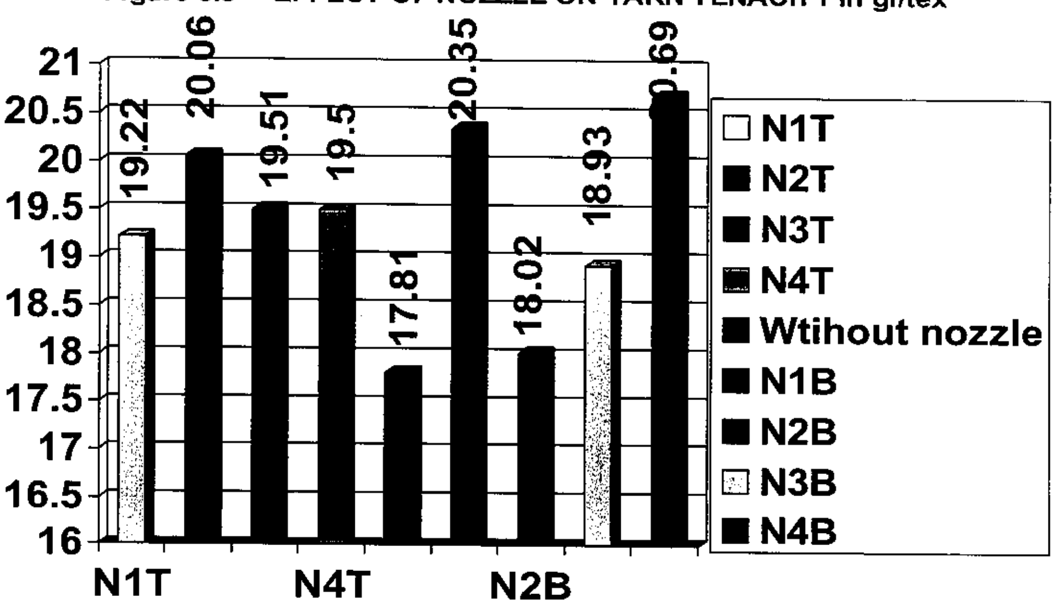


- So far considering the imperfection level the nozzle does not have a pronounced effect on imperfections.
- Even the nep level has raised to 68% in nozzle N2 when used in bottom position.
- But the effect seems to be much better when the nozzles are placed in top position.

5.5 Effect of Nozzle on Yarn Tenacity:

Tenacity of the yarn shows an improvement with the use of nozzles and is shown in Figure 5.5

Figure 5.5 EFFECT OF NOZZLE ON YARN TENACITY in gf/tex



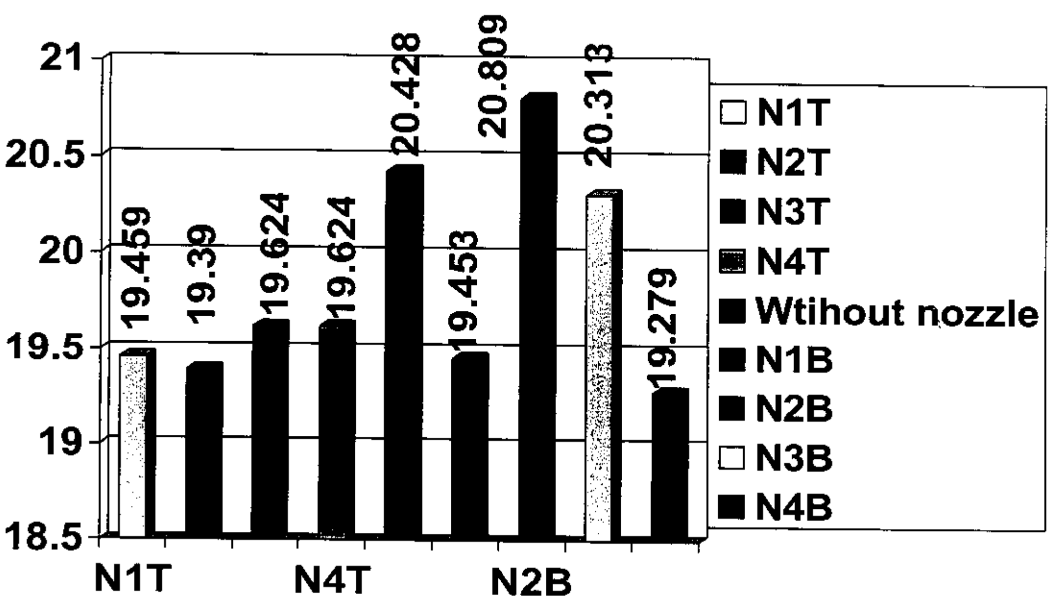
- A wide range of improvement is seen in tenacity of yarn when spun with Air jet nozzles.

- Nozzle N1 shows 7% improvement in yarn tenacity in top position and 12% improvement in bottom position.
- Nozzle N2 shows 11% improvement in yarn tenacity in top position and 1% improvement in bottom position.
- Nozzle N3 shows 9% improvement in yarn tenacity in top position and 6% improvement in bottom position.
- Nozzle N4 shows 9% improvement in yarn tenacity in top position and 14% improvement in bottom position.
- There is no significant difference observed in yarn tenacity when the nozzles are placed in top and bottom position.

5.6 Effect of Nozzle on Yarn Count:

The yarn has become coarser with the use of nozzles due to more compaction and shuffling of fibres and the values are shown in Figure 5.6

Figure 5.6 EFFECT OF NOZZLE ON YARN COUNT



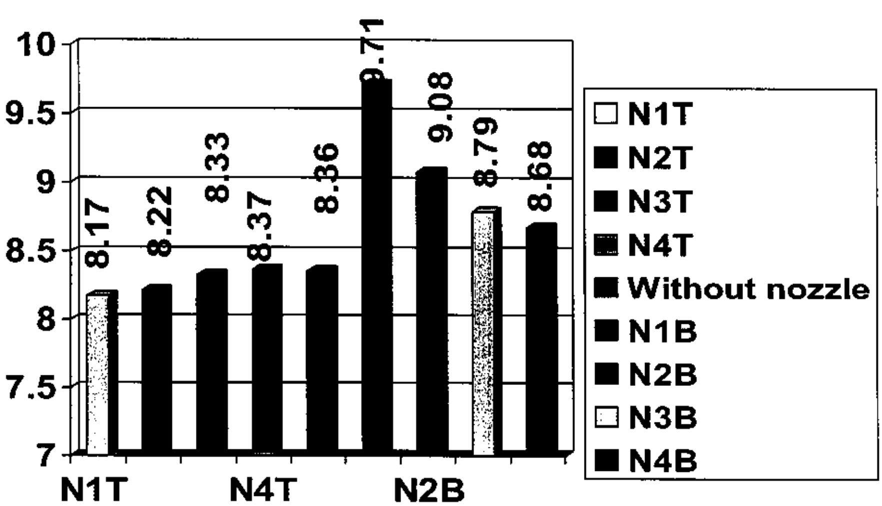
- An improvement in the range of 0.5% to 6% is observed with the nozzles which mean the yarn had become coarser with the use of nozzles.
- The reason may be the cause of short fibres to take part in the twisting region has become more and thus a fibre intact is achieved.
- Also with the nozzle N2 in bottom position the yarn had become slightly finer around 2%.

5.7 Effect of Nozzle on Unevenness%:

Though a considerable improvement is not observed in unevenness with nozzles a minor change is observed and is shown in Figure 5.7

Unevenness has a slight improvement when the nozzles are used in top position. But when the nozzles are used in bottom position U% gets raised.

Figure 5.7 EFFECT OF NOZZLE ON U%



5.8 Effect of Orifice Angle on Yarn Quality:

- As the nozzle vertical angle increases the hairiness value decreases.
- With the decrease in horizontal angle the hairiness value gets slightly reduced.
- Hence an increased vertical angle and a decreased horizontal angle would give a better reduction in hairiness value.
- The orifice angle does not have a pronounced effect on yarn tenacity. But a slight improvement in yarn tenacity is observed with increase in vertical angle.

5.9 Effect of Orifice Diameter on Yarn Quality:

- As the orifice diameter is increased from 1 mm to 1.5 mm a gradual reduction in hairiness is observed.
- Also the yarn tenacity gets increased with the increase in orifice diameter.
- The unevenness % and imperfections gets increased with increase in orifice diameter.

5.10 Effect of Twist Chamber Diameter on Yarn Quality:

- When the twist chamber diameter is reduced from 4mm to 3mm hairiness gets reduced.
- Yarn tenacity gets increased with decrease in twist chamber diameter.
- Imperfections also get increased with decrease in twist chamber diameter.

5.11 Effect of Nozzle Positioning On Yarn Quality:

- The performance of nozzle shows a better improvement on yarn unevenness when the nozzles are placed in top position than in bottom position.
- Imperfections gets increased when the nozzles are placed in bottom position.
- So far considering the yarn hairiness bottom position shows a better reduction in yarn hairiness when compared with that of top position.
- The yarns spun with nozzles placed in top position shows an increased trend in yarn tenacity.
- When considering the yarn count top position shows a steady improvement in binding of short fibres, where as this behavior is not significant when the yarns are spun with nozzles in bottom position.

5.12 Discussion of Results:

When the position is changed from Top to Bottom, the swirling air current gets weakened and the force is not distributed upto the twisting triangle. This restricts the fiber cohesion in the yarn. This results in increase in yarn Unevenness, reduction in yarn tenacity and increase in imperfections. Since the force is a weak force better alignment of fiber in to the core of the yarn is achieved and this results in decrease of yarn hairiness.

When the nozzle Horizontal angle is decreased, the radius of the swirling force is increased. With respect to the position, the reduced horizontal angle in the top position disturbs the fiber alignment and hence a higher hairiness value is observed in nozzle N2 in top position, where as in bottom position, since the force has become weak a positive result is obtained.

Increase in vertical angle also increases the radius of swirling force and also the number of turns of swirling force around the yarn. This helps in enclosing the fibres closer to the core and hence a reduction in yarn hairiness is achieved.

With the increase of orifice diameter, the width of the swirling force gets increased and hence the working on fibres also gets increased. This helps in increasing yarn tenacity, but this increased working force causes turbulence among the fibres and hence unevenness and imperfections gets increased.

When the twist chamber diameter is decreased, the working radius of the swirling force inside the nozzle is decreased. When this working radius is reduced, number of turns of force inside the nozzle gets increased and better cohesion and intact of fibres is achieved. This results in increase of yarn tenacity.

As the working force is increased, a slight turbulence of fibres results which causes the increase in unevenness and imperfections.

5.12 Properties of yarns spun with and without Air jet nozzle:

The Physical properties of yarn such as Count, Hairiness, Tenacity, Elongation, Unevenness and Imperfections of all the samples produced with and without using Air jet nozzles are shown in Table 5.1

Sno	Property	A1W	N1T	N2T	N3T	N4T	N1B	N2B	N3B	N4B
1	Yarn count (Ne)	20.4	19.45	19.39	19.62	19.62	19.45	20.8	20.31	19.27
2	Hairiness index (Zweigle)	786	464	490	396	152	413	187	239	79
3	Uster Hairiness index	7.3	6.43	6.22	6.03	6.09	6.94	6.97	6.7	6.53
4	Tenacity (g/tex)	17.8	19.22	20.06	19.51	19.5	20.35	18.0	18.93	20.69
5	Elongation%	6.45	6.83	7.17	7.07	6.99	7.01	7.06	7.08	6.99
6	U%	8.36	8.17	8.22	8.36	8.37	9.71	9.08	8.79	8.68
7	Imperfection Thin: -50 Thick: +50 Neps:+200	 - 20 34	 - 11 18	 - 11 16	 - 17 23	 - 18 32	 - 23 47	 - 30 109	 - 22 39	 - 21 35

Table 5.1 – Properties of yarns spun with and without Air jet nozzle

(A1W – Parent yarn; N1T to N4T – Nozzles in Top position; N1B to N4B – Nozzles in Bottom position)

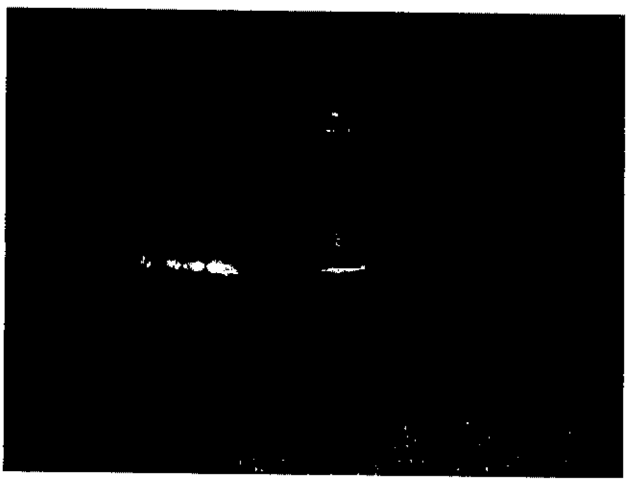
CONCLUSION

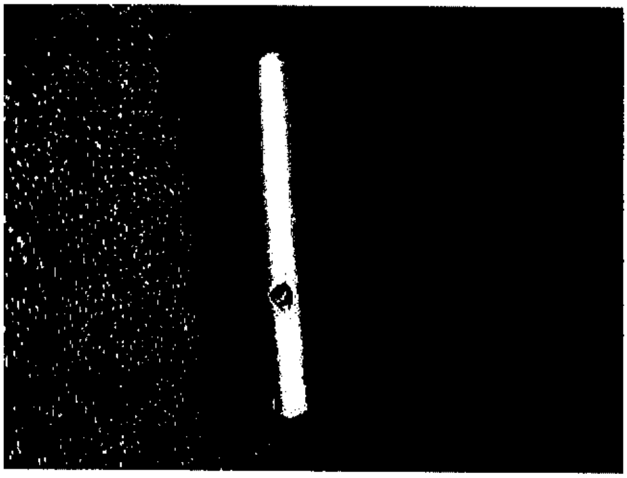
- As the nozzle Horizontal angle decreases, imperfections reduce which results in increase of yarn Tenacity up to 11.2%.
- As the vertical angle is increased hairiness value decreases. But a slight increase in unevenness value is observed.
- As the nozzle orifice angle increases, hairiness value reduces considerably from 39% to 81%.
- With the reduced Twist chamber diameter uster hairiness gets reduced from 6.32% to 6.06%. Also yarn tenacity gets increased with decrease in Twist chamber diameter.
- As the orifice diameter is increased from 1mm to 1.5mm a gradual reduction in hairiness is observed. Also the Yarn Tenacity gets increased with increase in orifice diameter.
- The performance of nozzle shows a better improvement on yarn evenness when the nozzles are placed in Top position than in Bottom position.
- So far considering the yarn hairiness bottom position shows a better reduction in yarn hairiness when compared with that of top position.

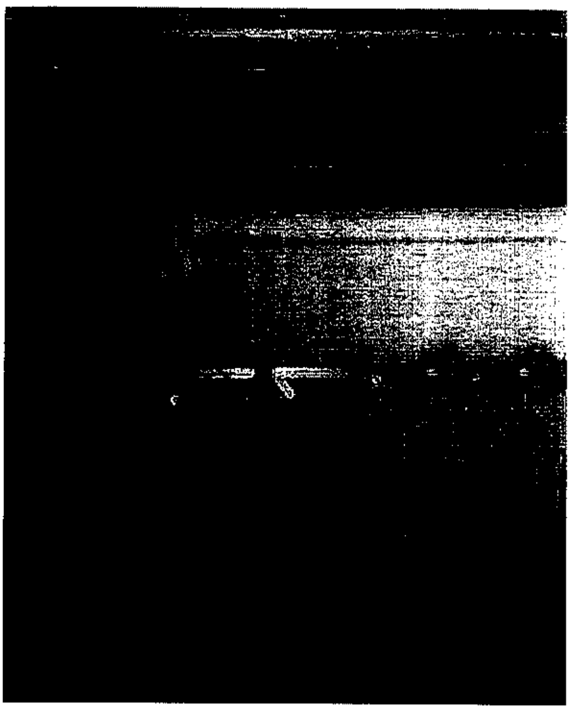
So far considering the results obtained from these four nozzles and analyzing them, the optimum nozzle would be

25^0 Hztl angle / 80^0 vtcl angle / 3mm Twist chamber dia / 1.5mm orifice dia i.e. Nozzle N4.

APPENDIX







REFERENCES

1) A P S Shawney & L B Kimmel, March 1997, Air and Ring combination in Tandem Spinning, Textile Research Journal vol 67, pp 217 – 223.

2) A R Kalyanaraman, 1992, A process to control Hairiness in yarn, Journal of Textile Institute vol 83 No 3, pp 407 – 413.

3) Boon Soo Jeon, November 2000, Effect of an Air suction nozzle on yarn Hairiness, Textile Research Journal vol 70, pp 1019 – 1024.

4) Chongwen Yu, July 1999, Open end spinning using Air jet twisting, Textile research Journal vol 69, pp 535 – 538.

5) K P Chellamani, D Chattopadhyay, K Kumarasamy, December 2000, Yarn Quality improvement with an Air jet attachment in cone winding, Indian Journal of Fibre and Textile Research vol 25, pp 289 – 294.

6) K P R Pillay, August 1964, A Study of the Hairiness of cotton yarn; Part I: Effect of fibre and yarn factors, Textile Research Journal, pp 663 – 674.

7) K P S Cheng and C H L Li, December 2002, Jet Ring Spinning and its influence on yarn Hairiness, Textile Research Journal vol 72, pp 1079 – 1087.

8) K Ramachandrulu and V Ramesh, December 2002, Design and Development of Twin Air jet nozzle for Ring spinning system, National conference for institution of Engineers, pp 126 – 134.

9) Wang, Miao and How, April 1997, Studies of Jet Ring spinning; Part I: Reducing yarn Hairiness with Jet Ring, Textile Research Journal vol 67, pp 253 – 258.

10) Y C Zeng and C W Yu, March 2004, Numerical and Experimental study on Reducing yarn Hairiness with Jet Ring and Jet Wind, Textile Research Journal vol 74, pp 222 – 226.

11) Y C Zeng and C W Yu, April 2003, Numerical Simulation of Air flow in the nozzle of an Air jet spinning machine, Textile Research Journal vol 73, pp 350 – 356.