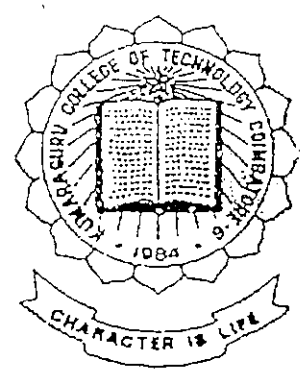
INFLUENCE OF PROCESS VARIABLES ON POLYSTER / COTTON BLENDED ROTOR YARN CHARACTERSTICS



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Synopsis

SYNOPSIS

In this work, we have made an attempt to study the influence of process variables on polyester blended rotor yarn quality characteristics .

Three counts viz., 10^S, 12^S and 18^S Ne were spun on open end spinning machine under appropriate process conditions, using two 50/50 and70 /30 Polyester / Cotton blends.

Thirty different yarn samples were produced by varying the rotor speed and separator angle. These samples were tested for basic yarn parameters like count, strength, CSP, U%, Imperfections etc..

The yarn test results were analysed and it indicates the following :

- An increase in yarn unevenness with an increase in rotor speed.
- The yarn elongation and yarn strength are found to reduce with the increase in rotor speed.
- An increase of separator angle improves the yarn evenness
- There is no significant change in the imperfections level by varying the separator angle.

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Introduction

INTRODUCTION

Man- made fibers and their blends are generally spun on conventional ring spinning system in India, due to limitation of spinning of higher counts in rotor machines. As per projection man- made fibers will occupy the share of about 35% of the total fiber consumption in India in 2000 A.D.

Further in the recent past many technological improvements have been made in rotor profile and its driving system. Hence a study on the rotor spinning technology for spinning man – made fibers and their blends will be useful and with this in mind the study was undertaken with the following objectives.

(i) To explore the possibilities of spinning blended yarns in rotor spinning machine.

(ii) To study the effect of process variables on blended yarn characteristics.

The influence of process parameters and separator angles on quality attributes of yarns produced from man- made fiber blends has been thoroughly investigated for indigenous rotor spinning machine. This study becomes relevant in view of the fact in ring spinning the yarn quality does not vary much between speeds, but in rotor spinning, rotor speed has got bearing on all yarn quality parameters and the extent of influence depends on the type of fiber and the type of rotor spinning machine under consideration.

Literature Review

LITERATURE REVIEW

Studies carried out by K.P.R. Pillai on spinning man made fiber blends indicates a decrease in yarn quality such as CSP and Tenacity with an increase in rotor speed. He has also found that the yarn irregularity and imperfections increase with the increase in rotor speed for polyester blends.

Research carried out at the B.D Institute, Czech highlights the following combing roller speeds of 5000 to 7000 rpm are suitable for processing man – made fiber blends.

From their experience a combing roller having an working angle of 97° giving a good separation. In spinning P/C yarn working angle of 99° and combing roller speed of 6500 rpm gives the best-blended yarn results.

Works carried out at the Torray Industry which investigated on the flexibility of spinning polyester fibers in open end spinning indicate that fiber finish, crimp%, elastic and frictional properties also have an effect on the quality of blended yarn to be spun.

P. Chellamani and et al found that the contribution of fiber strength towards yarn strength increases as the number of fibers in the yarn cross - section decreases while spinning polyester blends. Yarn elongation reduces with increases of rotor speed for almost all cases.

Methodology

METHODOLOGY

Polyester / cotton blends of two different proportions viz., 70/30 (P/C) and 50/50 (P/C) were selected for the study. The properties of cotton and polyester fibers used are given in Annexure II. A laboratory model rotor-spinning machine comprising twelve rotors was used for this study.

During spinning both rotor speed and separator angle were changed. Details of spinning parameters are presented in Annexure II. The methodology of material preparation prior to spinning is given in chapter I. During spinning both rotor and separator angles were changed.

ANNEXURE – I

Fiber Properties	Fiber Type	
	Cotton	Polyester
Length (mm)	26.1 mm	38.0 mm
Denier	1.32	1.2
Bundle Strength at 3 mm gauge	20.6	42.36
Maturity Co-efficient	0.78	-
Elongation	13.2 %	21.9%
Trash	5.44 %	-
Uniformity Ratio	47.8%	-

SAMPLE PLAN

ANNEXURE – II

Blends	Rotor Speed	Separator Angle
70/30 P/c	40,000 rpm	15^0
	45,000 rpm	45^0
	50,000 rpm	90^0
50/50 P/c	40,000 rpm	15^0
	45,000 rpm	45^0
	50,000 rpm	90^0

Count Spun :- 10S, 12S, 18S [Both for 50/50 P/c and 70/30 P/c]
Number of Spinning :- 4

PROCESS FLOW CHART

BLOW ROOM

↓

CARDING

↓

DRAWING – I (BREAKER)

↓

DRAWING – II (FINISHER)

↓

OPEN END SPINNING

BLOW ROOM PREPARTION:

In preparation of lap L.R Blow room was employed with the following sequence of machines.

PROCESS FLOW IN BLOW ROOM

MBO

MONO CYLINDER

STEP CLEANER

KRISHNER BEATER

SCUTCHER

During the process 0.00158 hank was maintained. The trash and the cotton lap was found to be 0.48 % .Two separate lap one for each blend was chosen.

CARDING:

LRC I / 3 Card was employed to produce a Sliver. In this process the Sliver hank was maintained at 0.158.

The Speeds of Carding Process are:

Lickerin	-	600 rpm
Cylinder	-	300 rpm
Doffer	-	16 rpm
Flats	-	10 inches / min.

DRAWFRAME:

The Sliver was doubled and drafted on a LR DO / 2S draframe. Two passages namely breaker and finisher were employed.

Both the finisher and breaker's delivery rates were maintained at 200 m / min. The Sliver Hank was 0158. Trash in Sliver was 0.13 %.

OPEN END SPINNING

The most important machine parameters that should be taken into account when blended fibers are blended are

i) The operating roller (or) combing roller (Speed and clothing)

ii) The feed system (Relative setting and pressure)

iii) The yarn winding system

In determining the opening roller we should consider in mind the fiber type, length and fineness. In determining the opening roll speed we should also consider the risk of excessive fiber shortening, nep formation, fiber fusing and cloudiness in the fiber bend inside the spinning chamber current mill experiences and past research literature suggests that with the polyester blend fibers good yarn quality and low breakage rated were obtained with combing (or) Opening roller speed between 5000 – 7000 rpm.

So it was decided to operate the opening roller speed at 6000 rpm throughout the whole study.

With synthetic fibers it is important to maintain the flat position of the silver. More over the pressure between the pressure plates and the feed roll should be optimum. This ensures sufficient grip and trouble free feed of silver.

The following adjustments were done in the M/C while processing of P/c blends.

1) The pressure plate setting was set close after some trails based on the following observations.

2) With initial trials with a wider pressure plate setting problems like feed roll loading and combining roll loading accrued frequently. The causes are likely to be

   a) Due to insufficient grip and pressure between feed roll and pressure plate and due to the presence of longer fibers, the material instead of being fed fringe by fringe basis, a bunch was directly pulled by the opening roller and the material which is synthetic which is generally of slippery nature got loaded.

Testing

TESTING

The yarns spun on rotor spinning machines are tested for he following characteristic :

Yarn Testing:

The various yarn tests carried out are as follows.

1) Count

   a) Count – Strength Product

   b) Yarn evenness and Imperfection

Count:

Taking 20 samples from 8 chases checked Count of yarn. The samples were prepared by taking 120 yards of yarn using wrap reel. These samples were weighed and the count was determined by using the following formula.

$$\text{Count} = \frac{64.8}{\text{Wt in frames}}$$

Results obtained are given in the next section.

CSP (Count strength product):

The lea CSP was tested on a MRG lea strength tester working on CRT principle. The samples which was used for count determination was speed for strength measurement also. Having this values lea CSP was calculated. The Lea CSP results are provided in the next section.

Yarn Evenness and Imperfections:

Yarn evenness and imperfection, such as thick, thin and neps are tested using ELCOT Maset 03 Evenness tester. A testing speed of 200 m/min was maintained. For each sample 10 tests were carried out. Results of the evenness and imperfection are provided in the next section.

Result and Discussion

INFLUENCE OF ROTOR SPEED ON YARN EVENESS

There is found to be a steady detoriation of the yarn evenness with increase in rotor speed. The results of the yarn evenness are given in the tables 1.1 & 1.2 ,for both 50/50 and 70/30 blends.

The u% at rotor speeds 55,000 rpm is 12.78 for 10^s count, 50/50 blend which is significantly higher than at 45,000 rpm which is 11.84 as shown in the table 1.1. The unevenness of the yarn of 12^s and 18^s count also shows a significant change for increasing rotor speed .

In the case of 70/30 (p/c) blend the u% has significantly increased from 9.82 to 11.09 for rotor speeds of 45,000 and 55,000 for 10^s as shown in table 1.2. The unevenness of the yarn is found to increase for both 12^s and 18^s count with the increase in rotor speed.

The lack of fiber individualisation at higher rotor speed seems to have adverse effects on yarn quality in both the blends. The fibers being not under positive control tend to lie haphazardly inside the rotor groove at higher speeds.

Blend:- 50/50 (p/c)

Table 1.1

otor speed (rpm)	Yarn count		
	10^s (u%)	12^s (u%)	18^s (u%)
45,000	11.84	12.93	13.7
50,000	12.53	12.9	13.8
55,000	12.78	13.2	13.6

Blend:- 70/30 (p/c)

Table 1.2

or speed (rpm)	Yarn count		
	10^s (u%)	12^s (u%)	18^s (u%)
45,000	9.82	10.20	11.92
50,000	10.20	10.23	11.32
55,000	11.09	10.36	11.80

INFLUENCE OF ROTOR SPEED ON YARN IMPERFECTIONS

The Yarn Imperfections were found to increase with an increase in the rotor speed. The results are given in the tables 2.1 & 2.2 the imperfections tend to increase for both the blends. The total Imperfections were found to increase drastically for 50/50 (P/C) blend.

At higher speeds the degree of opening and combing of the fringe and also the draft between feed roll is reduced. This results in the loss of combing roller efficiency and hence contributes to higher yarn Imperfections.

The detoriation in the fiber arrangement at higher rotor speeds leads to an increase in the Imperfections level. Another feature is the nep level as shown in the table 2.1 and 2.2 which shows a steep increase in nep level in the yarn as the rotor speed increases.

According to user manual, neps are differentiated from thick places by the length of the defect, those shorter than the fiber length getting counted as neps. O.E yarn are characterized by the presence of wrapper fiber(Or)belts and it is known that the frequency of wraps increase in the rotor speed.

The presence of wrapped fiber occurs the yarn has a greater mass/unit length because the greater Fiber mass wrapped around the yarn. It appears that from the results obtained the evenness has recorded such wrapper as neps. Thus the steep increase in nep level. With increased rotor speed is partially due to higher wraps at higher wraps at higher speed.

LE 2.1

70/30 (P/c) Yarn Imperfection

ant	10^S Ct			12^S Ct			18^S Ct		
tor eed	Thick	Thin	Neps	Thick	Thin	Neps	Thick	Thin	Neps
000	4	0	7	5	2	27	8	2	52
000	5	0	11	4	0	21	4	1	43
000	5	2	23	2	1	22	7	3	59

2.2

50/50 (P/c) Blend

t	10^S Ct			12^S Ct			18^S Ct		
	Thick	**Thin**	**Neps**	**Thick**	**Thin**	**Neps**	**Thick**	**Thin**	**Neps**
)	102	9	129	89	23	127	73	42	120
)	116	7	185	69	42	189	89	47	339
)	184	12	193	71	37	278	87	39	445

INFLUENCE OF ROTOR SPEED ON YARN QUALITY

YARN STRENGTH AND YARN ELONGATION:

The table 4.1, 4.2 &4.3 shows the yarn strength and elongation at various rotor speeds increases in all the cases for both the blends (50/50 , 70/30) & all counts. Table 4.1 shows the drop in yarn strength, from 2870 to 2673 CSP for rotor speeds of 45,000 & 55,000 respectively, for 10 Ne (50/50) blend. The yarn strength and elongation detoriates in the case of 12^s & 18^s ct with increase in rotor speed which is found to be significant.

Similarly in the case of 70/30 blend as shown in table 4.2 the yarn strength reduces significantly in the case of 10^s from 2897 to 2603 for rotor speeds at 45,000 to 55,000 respectively. As for as the finer counts such as 18^s are concerned the yarn strength detoriation is significant.

It appears that high temperature inside the rotor at higher Speed causes detoriation in yarn strength. Due to the high centrifugal forces, the yarn may be expected to abrade more severely with the navel which is likely to effect the yarn strength.

YARN ELONGATION:

Yarn elongation is very sensitive to rotor speed. As the rotor speed increases the yarn elongation seems to detoriate as shown in table 4.1, 4.2 & 4.3 .

At higher rotor speeds, the centrifugal force presses the fiber ring firmly in to rotor groove. The fibers are thus peeled off and twisted at higher tensions during spinning.

As a result the yarn becomes compact and the curliness of the fiber reduces resulting in a reduction in yarn diameter and yarn elongation. It has also been observed that as the rotor speed increases, the no. of wrapper fibers increases which is likely to inhibit fiber strain along the length tending ultimately to loss in elongation.

TABLE : 4.1

10^S Count

Blend	50/50		70/30	
Rotor Speed	**CSP**	**Elongation**	**CSP**	**Elongation**
45,000	2870	10.02	2897	9.6
50,000	2722	9.80	2782	9.40
55,000	2673	9.23	2603	9.30

TABLE : 4.2

12^S Count

Blend	50/50		70/30	
Rotor Speed	**CSP**	**Elongation**	**CSP**	**Elongation**
45,000	2872	9.02	2987	9.2
50,000	2803	8.80	2926	9.0
55,000	2789	8.23	2899	8.70

TABLE: 4.3

18^S Count

Blend	50/50		70/30	
Rotor Speed	**CSP**	**Elongation**	**CSP**	**Elongation**
45,000	2970	9.76	3102	9.23
50,000	2912	9.57	3076	8.97
55,000	2879	9.14	3022	8.74

INFLUENCE OF SEPARATOR ANGLE ON YARN QUALITY

Though much studies have not been done on the influence of separator angle, trials were conducted by adjusting the separator angle in 3 different position viz 15^0 , 45^0 & 90^0.

As already known as per the profile of the separator plate, it mainly guides the fibers in a pre-determined timing into the rotor groove. The effects that are likely to take place in the yarn quality due to varying separator plate angle are given in the next section. The table 5.1, 5.2 & 5.3 show the yarn evenness for given separator angle with respect to their particular count.

INFLUENCE OF SEPARATOR ANGLE ON YARN EVENNESS

It is found that the U% is found to reduce nearly by 1.36 % for a change in angle from 15^0 to 90^0 for 10^S Count for 50/50 (P/c) which is found to be significant. While as the count goes finer as the case of 12^S & 18^S there seems to be a much significant change in U% for both blends.

There is a reduction of 3.90%, 1.84% U% for 12^S for blends 50/50 & 70/30 from an separator angle of 15^0 to 90^0 respectively where as for 18^S the U% is

reduced by 1.73%, 1.36% from 70/30 & 50/50 (P/C) blends for angles 15^0 to 90^0 respectively.

It can be found from tables 5.1 & 5.2 & 5.3 the yarn evenness improves at a separator angle of 90^0. This due to the fact that this angle allows the fiber to get relaxed after being individualized which reduced the internal stresses in the fiber.

Thus fibers transferred into the rotor in a slightly delayed timing in the case of 90^0 as compared to 15^0 which helps to produce an even yarn.

TABLE 5.1

YARN EVENNESS

10^S ct

Rotor speed	70/30 (P/c) U%	50/50 (P/c) U%	Separator angle
50,000	13.70	12.86	15^0
50,000	13.35	12.63	45^0
50,000	12.36	12.20	90^0

TABLE : 5.2

12^s ct

Rotor speed	70/30 (P/c) U%	50/50 (P/c) U%	Separator angle
50,000	14.89	16.24	15°
50,000	4.02	10.56	45°
50,000	13.92	9.72	90°

TABLE : 5.3

18^S Count

Rotor speed	70/30 (P/c) U%	50/50 (P/c) U%	Separator angle
60,000	10.89	12.24	15°
60,000	10.75	11.56	45°
60,000	9.02	10.20	90°

YARN STRENGTH AND YARN IMPERFECTION:

Rotor Speed – 50,000

10^S ct

	50/50 (P/c)			70/30 (P/c)		
Separator Angle	CSP	Total Imperfections Per Km	Elongation (%)	CSP	Total Imperfections Per KM	Elongation
15^0	2686	420	9.3	2763	562	9.3
45^0	2692	440	9.0	2769	560	9.1
90^0	2782	487	9.2	2873	579	9.0

12^S Count

	50/50 (P/c)			70/30 (P/c)		
Separator Angle	CSP	Total Imperfections Per Km	Elongation (%)	CSP	Total Imperfections Per KM	Elongation
15^0	2862	562	8.6	2870	502	8.6
45^0	2871	560	8.4	2872	567	8.5
90^0	2960	543	8.3	2973	507	8.5

18^S Count

	50/50 (P/c)			70/30 (P/c)		
Separator Angle	CSP	Total Imperfections Per Km	Elongation (%)	CSP	Total Imperfections Per KM	Elongation
15^0	2823	472	8.3	3166	512	8.6
45^0	2890	502	8.1	3172	479	8.4
90^0	3102	512	8.2	3276	523	8.5

The C.S.P values are found to improve marginally from 15° to 90° for almost all cases in both the blends. The C.S.P is found to increase by 10-12% with a change in separator angle from 15-90° in almost in all cases.

As for as the yarn strength is concerned there is a slight improvement in the case of both the blend for 10^S Count the CSP is found to improve from 2686 to 2764 and 2763 to 2812 for 50/50 & 70/70 for 10^S Count from a separate angle of 15^0 to 90^0.

The increase CSP is found to be significant in the case of 12^S Count 50/50 blend. The CSP values are found to be increase from 15^0 to 90^0. For almost all cases in both blends .

As for as the yarn elongation is concerned there does not have a significant change in almost all the cases in both the blends.

In the case of yarn imperfection, there is no significant change in increase in the case of 50/50 P/c for 10^S Count. While taking in to consideration the other case there is no much significant change.

The improvement in yarn strength is due to the increase in the bridge gap between the fiber feeding point and the yarn take off point with an increase in separator angle.