Study on effectiveness of Siro yarn over normal Ply yarn with the aim as a replacement of doubled yarn processing

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Abstract- **After the introduction of Siro spinning process so many new windows have been opened in the ring spinning techniques. A lot of studies has been made on Siro process. But a comprehensive study on both the Siro and normal Plying processes is found scanty. In this study we have focused to show the comparative yarn properties keeping all the processing parameters same. However, this study is not an exhaustive study. A lot of pathways have been shown to arrive at a suitable decision to replace the yarn doubling process by Siro spinning in one step. We have suggested these in a brief manner. Our study is limited on only acrylic fibre material in a state of art spinning mills.**

Key words: **Siro yarn, ply yarn, yarn regularities, classimate faults.**

1. Introduction:

Single yarn is not sufficient to weave some special end use fabric of daily use, like high drape fabric, canvas fabric, tent fabric and other heavy weight fabrics. This is due to the low strength of single yarn. To overcomethis problem, spinners introduced double /ply yarn. Such yarn not only increases the tensile strength but also gives a smoother yarn appearance in terms of locking of protruding fibres into the yarn surface. The introduction of doubling-twisting machine being essential part of spinning process becomes popular amongst the spinners. But to get a ply yarn an additional process and/ or machine has to be established in the mill. The limitations of this concept in the practical field are as follows:

i)additional space to be blocked, ii) energy consumption and power bills to be incurred, iii) human hazards due to engagement of additional operators, iv) increase in maintenance and inventory cost to be generated, v) due to addition of an extra process, time to produce final yarn as well as delivery schedule to be delayed compared normal single yarn, vi) finally a huge initial capital cost to be borne by the owner.

Keeping in mind the above limitations and a long awaiting spinners' demand for proper solution CISRO developed the concept of Siro spun technology for worsted system. The same is now adopted for cotton system. Many of the mills are now using this technology by fitting simple Siro attachment. The benefit of this attachment is that, the same machine can be used as ring spinning for single yarn when the Siro-complete is dismantled and when required the fitting is attached to get a pseudo two folded effect in the yarn.

There are so many literatures published on Siro spinning process cateringtoits economic benefits, quality characteristics, creel spacing etc. but references on whether this Siro yarn is better or inferior in different mechanical properties with respect to ring spun-two-fold yarn is scanty. Our study focuses on the mechanical and aesthetic characteristics of these two yarns.

2. Literature review:

The Siro spun ™ is a brain child of CISRO in the early '80. Using the same ring frame arrangement like drafting system, spindle and ring traveler, two rovings are processed together, placed side by side with a specified distance of separation of rovings, a yarn is produced by entrapping the protruding fibres in the yarn surfaces. The yarn is produced having lesser hairiness and higher abrasion resistance [1].

Basically modifying the spinning trianglegeometry, the yarn is made having smoother appearance thantwo-fold conventional ring spun yarn. The technology started using long staple worsted fibres but nowadays system has beendeveloped with short staple fibres also [2].

Almost 150 years of waiting, after the introduction of ring spinning process (started in 1832) Siro spun technology comes to offer a probable replacement of ply yarn spinning system in a single step. Unlike other alternate spinning system, like open-end spinning, Siro yarn has almost same productivity as it uses modified ring spinning techniques.

Not only staple fibres but also Siro spinning technology is equally suitable for filament fibres spinning. A strength enhancement can be achieved using this system [3].
The fibre migration in ring spinning triangle in conventional ring frame results in yarn hairiness. Hairinessisnot only responsible for poor U% but also enhance extra energy consumption in ring spinning twisting and wind operations. It also shows poor efficiency in fabric production in loom and ultimate fabric willbe prone to pilling. Removal of hairiness also needs an extra process of singeing. In Siro spun technology the pre-twisted sub-strands are entered in the yarn forming zone and almost all the fibres are trapped into the yarn surface thus reducing hairiness [4].
Siro spinning system is a development over conventional ring spinning system using strand spacing of sub-strands. The yarn properties mostly depend on this strand spacing in terms of better fibre migration resulting higher tenacity [5].
Siro spinning is invented by division of Textile Industry Laboratories of the CISRO in Australia and IWS together around 1975-1976[6].

3. Experimental:

Different studies were made and papers have been published mentioning yarn strength and evenness. But no such paper was found in a comprehensive mode specifying all the yarn primary properties. In this paper we have shown a comparative study on different yarn characteristics in a single table.
Our study originates from the concept of comparison of quality characteristics by processing same count in Siro process and ring doubling process from the same mixing of raw material. The produced yarns are studied for its mechanical properties and appearance at yarn stage using yarn appearance board.

4. Materials and method:

We have experimented in a standard mill of West Bengal using two separate mixing of 100% polyester and 100% acrylic. The prepared roving from those mixings were taken as raw material. The machines, where this study was conducted were LF-1400A simplex of 1000 rpm spindle speed, NMM ring frame of 12,000 rpm spindle speed and Muratex TFO. The fibre specification for acrylic was 1.2D and 38mm with olive brown tint and for polyester 1.4D and 38mm with royal blue tint. Roving hank was set to 1.6.
Both polyester and acrylic rovings were fitted at same creel in same drafting zone. The strand spacing was same for both materials as 7mm.[7] All other mechanical parameters like TPI, spacers, etc. kept same. A special Siro attachment to separate the rovings before entering the back rollers was designed. The TM for different counts wasset as shown in the table-1. The single yarns were plied in TFO with TM set so as to get 75% TPI of single yarn. The rovings were processed first for all three single yarn counts (40s, 48s & 60s), then for Siro yarn counts (20s, 24s & 30s). Drafts, TM & TPI are mentioned in table-1.
The testing parameters which were evaluated were tensile strength, CSP, count CV, strength CV, total imperfection and U%. Yarn appearance was checked to conclude on the aesthetic feel of yarn. The results are shown in table-2. The machines used for testing purpose were Statex wrap reel and tensile tester, Techno yarn appearance winder and Uster Tester-5. Yarn Classimate faults were tested to infer on process-ability of the produced yarn in the successive stage.

Table 1: Yarn parameters for single, ply and siro yarn

Roving hank	Single yarn count	Draft	TM	Single yarn TPI	Ply yarn count	Ply yarn TM	Ply yarn TPI
Single yarn							
1.6	40s	25	3.5	17.5	2/40s	2.94	13.13
1.6	48s	30	3.5	24.2	2/48s	3.70	18.15
1.6	60s	37.5	3.5	27.11	2/60s	3.71	20.33
Siro yarn				Siro TPI			
2/16	20s	25	2.94	13.15	-	-	-
2/16	24s	30	3.7	18.13	-	-	-
2/16	30s	37.5	3.7	20.27	-	-	-

5. Results and discussion:

After production of three types of Siro yarn and ply yarn, yarn properties were studied as follows:(shown in table 2).

Table 2: Properties tested of Siro and ply yarn

Properties	Siro 20s	Ply 2/40s	Siro 24s	Ply 2/48s	Siro 30s	Ply 2/60s
Av. Count	19.39	19.44	23.66	23.79	29.9	28.45
Av. Tensile strength(lb-wt)	179.3	148.5	125.6	116.4	99.6	90.3
Av. CSP	3477	2888	2988	2754	2978	2569
Count CV(%)	1.25	1.34	1.10	1.27	1.17	1.88
Strength CV(%)	5.68	4.29	4.08	4.60	3.63	5.17

Thin places/ km	0	0.8	3.3	10.8	36.7	3.8
Thick places/km	2.9	6.3	7.9	12.5	46.7	37.1
Neps/km	5.0	7.1	19.6	12.1	18.8	261.7
IPI/km	7.9	14.2	30.8	35.4	102.2	302.6
U%	8.42	9.17	9.94	10.51	10.31	11.98
Objectionable Classimate faults	0	0	6.7	9.1	5.6	0

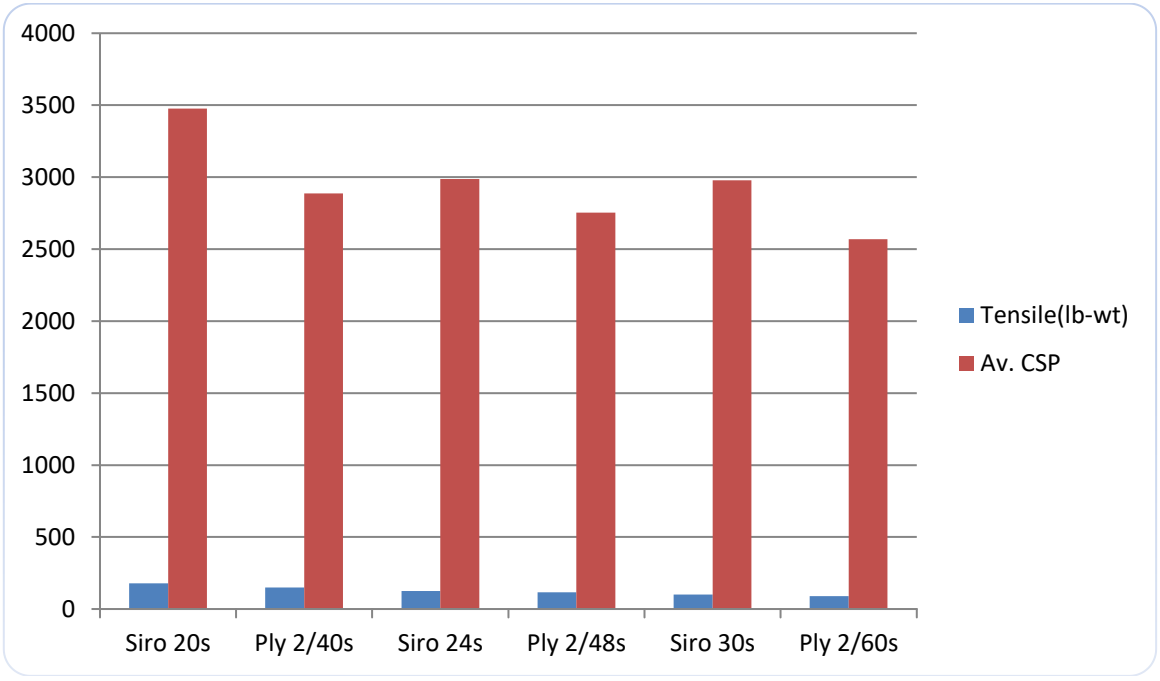

Figure 1: Comparative characteristics (tensile & CSP) of different Siro and ply yarn

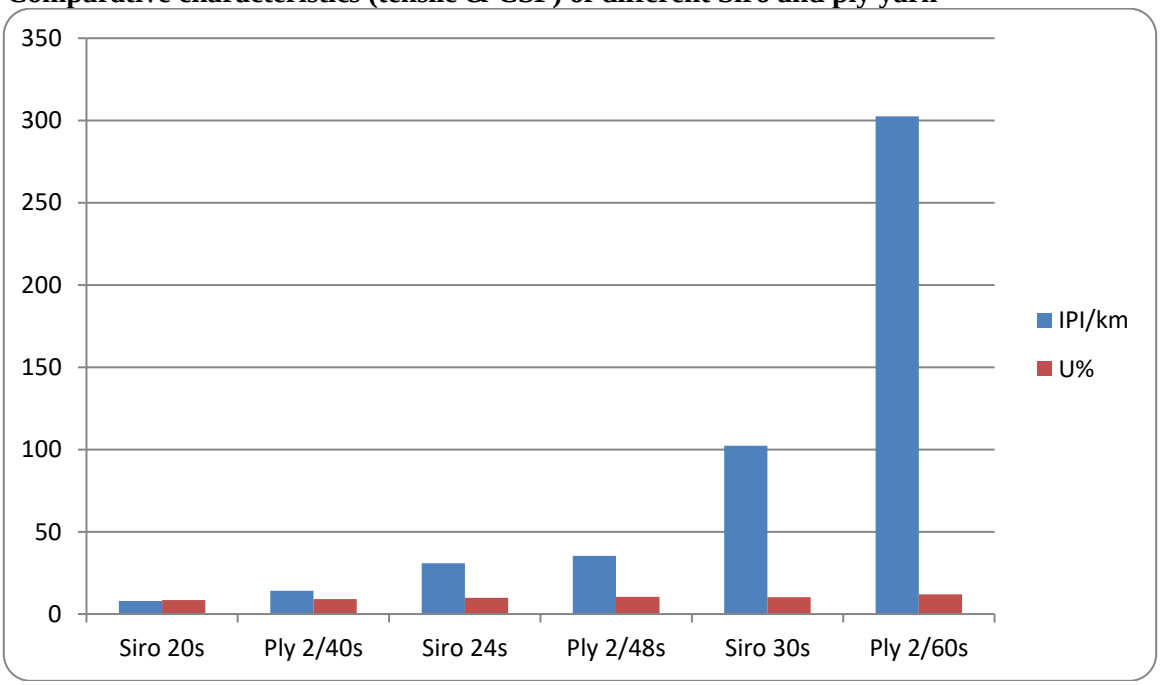

Figure 2: Comparative characteristics (IPI&U %) of different Siro and ply yarn

6. Conclusion:

It is observed from the above tables and figures that the CSP of the Siro yarn was higher than the TFO yarn which is due to less hairiness in the Siro yarn structure. USTER and IPI results indicate that the Siro yarn gives better uniformity than the ply yarn which is due to short spinning triangle and control of protruding fibres during yarn formation. The yarn appearance board establishes the theory of spinning triangle. From the yarn appearance board, we can conclude that the hand feels of fabric made from Siro yarn will be smoother than that of fabric made from ply

yarn. The objectionable faults from the Classimate result reveal that the seldom occurring faultsare less in case of Siro yarn which indicates better working condition and more productivity for Siro spinning.

From the above study it is clear that in terms of yarn quality Siro yarn is much better than that of normal doubled yarn. Doubling is an extra process in spinning which involves extra men, materials and time. Also due to introduction of an extra process there is a chance of generation of faults in terms of human error as well as quality point of view. Keeping all these in mind we can go for Siro process as an alternative of ply yarn production, though we cannot fully eliminate the doubling process as it has some other utilities in the production of cord yarn.

The study can be extended in a more specific way by changing the mechanical parameters to get the process ability of the Siro spinning. The yarn breakage should be taken to get the actual productivity.

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