International Journal of Applied Engineering Research ISSN 0973-4562 Volume 10, Number 24 (2015) pp 44214-44220

A Detailed Investigation on the Production Improvement of ZARI Yarn using WRAP Spinning Machine

S. Sundaresan

Assistant Professor (SRG), Department of Textile Technology Kumaraguru College of Technology Post Box No: 2034 Chinnavedampatti, Coimbatore-641049 Tamilnadu, India+919443481084 shobsundar@gmail.com

K. Thangamani

Professor, Department of Textile Technology Kumaraguru College of Technology Post Box No: 2034 Chinnavedampatti Coimbatore-641049 Tamilnadu, India+91843235996 ktmanithanga@yahoo.co.in

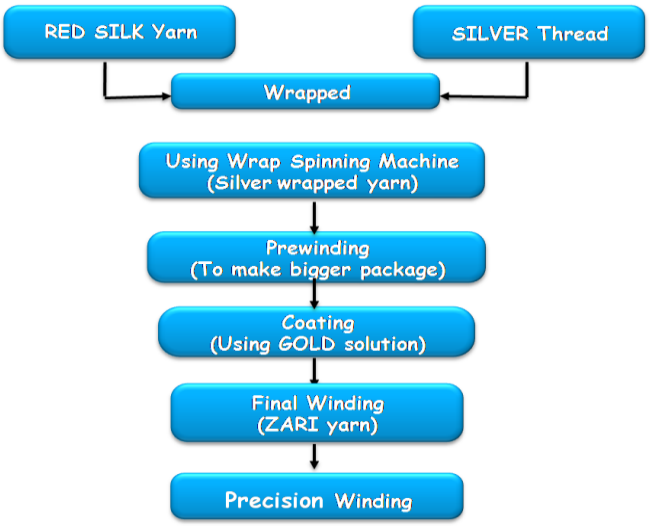
Abstract:
The textile sector in today's scenario is moving towards value addition products and new innovation. Lot of developments has been taking place in Machinery, Technology and New product development. The textile field is expanding its using through Technical Textiles, Medicals Textiles, Nano technology etc.., In this regard one of the most valued products is made by using silk yarn. The silk yarn can be converted to metallic yarn which is commercially known as ZARI yarn. This type of highly precious yarn is mostly used for making sarees which is of most valuable cost. The Zari yarn is manufactured by using wrap spinning machine which consists of hollow spindle. For manufacturing Zari yarn silk silver and gold were used. The wrap spinning machine is the heart of Zari yarn production, which wraps the silver wire on to the silk thread. In the wrap spinning process due to lack of tension control and technology up gradation the production/ spindle (in gms) in the wrap spinning is very low. Also the breakage rate is so high and it leads to higher wastage of silver and silk. In this research work an attempt is made to improve the productivity of wrap spinning and thus by reducing the wastage by incorporating the tension control devices and technological factors in the wrap spinning machine

Key words: wrap spinning, hollow spindle, silver wire, Tensioner, Zari yarn, breakage rate.,

Introduction

To have a improved production in wrap spinning tandem spinning has been developed using the modern spinning methods like air jet and friction spinning [1, 2]. The level of false twist can significantly influence yarn appearance and mechanical properties [3). The breaking strength and elongation of hollow spindle wrap sun were influenced by machine variables [4]. The structure of hollow spindle wrap yarn depends on the wrapping filament linear density [5].Mathematical model developed to predict the yarn strength and stress behavior for wrap spun yarn [6]. Introduction of false twister prior to wrap spinning reduces the fly and roller lapping and also the wrap sun yarn structure varies due to wrapping filament unwinding conditions [7]. The role of false twister in the formation of yarn was also analyzed and the study shows the false twister has an influence in yarn structure of wrap spun yarn [8]. Most of the research efforts in the field of plain wrap yarns were dedicated to the influence of the basic machine parameters on yarn structure and quality. Several papers showed the importance of the wrapper and its twist around the core for the mechanical properties of the final yarn [9, 10].

1. BASIC TECHNOLOGY OF ZARI MANUFACTURING



1.1 STAGES OF ZARI YARN MAKING

1. Flattening (Silver Wire).
2. Wrap Spinning.
3. Gold Solution Preparation.
4. Coating.
5. Post-winding

1.2 Flattening (Silver Wire).

The Red Silk Yarn of 14, 16 Denier (combined yarn) is used for the core. The Silver wire of 16 Micron diameters is first made flattened cross-section by using a flattening machine by applying optimum pressure (figure 1) and it is wound on small spools called as "Reels". Each reel contains 1000 to 1500 Meter of length of silver wire.

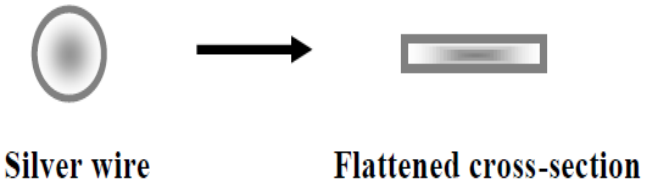


Figure 1-Silver Wire

The purpose of flattering is to increase the cover area and reduce the consumption of silver to cover the Red Silk during wrapping zone.

1.3 Wrap Spinning

The red silk is wrapped around by the silver thread by using the Wrap Spinning machine (Figure 2). The wrap spinning machine consists of a Hollow Spindle through which the Red Silk is passed from the creel. The reel containing silver wire is loosely mounted over the hollow spindle and passed through a finger called wrapping finger.

The spindle is positively rotated the by the drive from motor as shown in Fig. The take up roller is arranged in such a way that it pulls the Red silk from the supply package during the course of winding or wrapping. The guiding finger makes the silver wire to wrap around the passing Red silk yarn emerging out the hollow spindle.

The delivery package is wound on a double flanged spool; under optimum tension. The spool is taken to the precision winding machine in which a larger package is made, which helps to easy handling during the subsequent process.

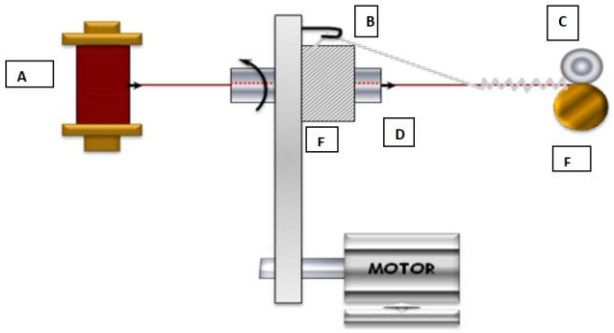


Figure 2 :Wrap Spinning Machine MACHINE PARTS: A-SPOOL (Red Silk) B-Wrapping Finger C-Delivery Package D-Hollow Spindle E-REEL (Silver) F-Winding Drum

1.4 PREPARATION OF GOLD SOLUTION

The gold (24 carrots) biscuit is converted into thin paper like sheet by passing through repeatedly to the pressing machine (Figure 3). The thin film sheet is torn into small pieces by manually. The pieces of gold are immersed in the electrolysis solution bath and the coating of gold on to silver wrapped ZARI yarn is done by electrolysis method. The instrument is based on electroplating principle (Figure 4). It consists of an anode and cathode. The anode is made up of nickel and cathode is a silver rod, the mediator solution is prepared by dissolving cyanide in water.

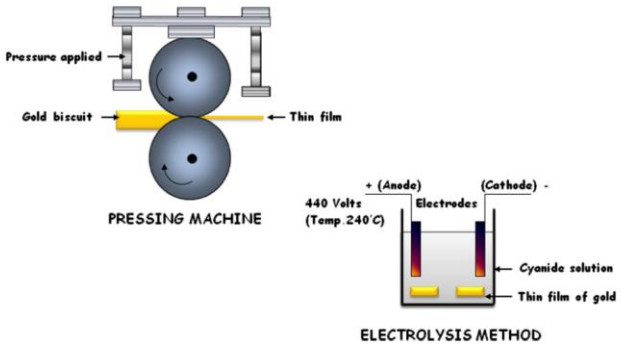


Figure 3 &4 : Pressing and Electrolysis process

1.5 COATING PROCESS

This process (Figure 5) consists of series of immersion rollers and heaters. Initially the silver thread is passed through a cold and hot water bath to remove any suspended impurities. Then it is processed through a bath containing potassium hydroxide solution kept at 90`C (under 20% concentration).This process act as a catalyst in order to make the silver to attract the gold plating.

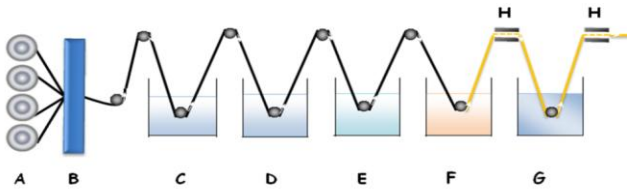


Figure-5 Gold Coating Process PARTS A-Supply package B-Creel C-Cold water (Pure) D-Hot water E-Potassium hydroxide @ 0‘C, 20 % Con. F-Gold solution @ 240’C G-Washing H-Drying & Winding

Then the yarn is passed through a gold solution at 240`c where the silver is coated with gold. The yarn is passed through the electrically heated plates to fix the gold plating and through a water bath to extract the residual gold in the yarn and finally passed through another heater and to the take up system where the Zari thread is wound on double flanged bobbins.

1.6 PRE WINDING AND POST WINDING

The Zari spools obtained from the coating department is wound on wooden spools. By this process the faults are cleared manually in the final yarn. In the post winding process the final Zari yarn is wounded on flanged small wooden spools under constant tension and constant length. Each spool is of 64.8gms net weight and a package of 4 bobbins is called one "Mark".

2.METHODOLOGY

The wrap spinning plays a major role part in producing the ZARI yarn. The wrapping of silver wire on to the silk yarn is done by using wrap spinning machine. The production rate will be 4 gms/spindle/8hours. The very low production is due to the excessive breaks during spinning or wrapping process.

To overcome the above said drawback a detailed study has been made to analyze the performance of wrap spinning machine. The study was conducted to find the cause and remedies, so as to improve the production and productivity of the machine.

2.1 The study was conducted in stages as follows:

1. Performance analyses of the machine without any modifications
2. Performance analyses of the machine with improved condition
3. Performance analyses of the machine with improved, fine tuned final condition
4. Performance analyses of the machine with improved, fine tuned final condition with increased speed.

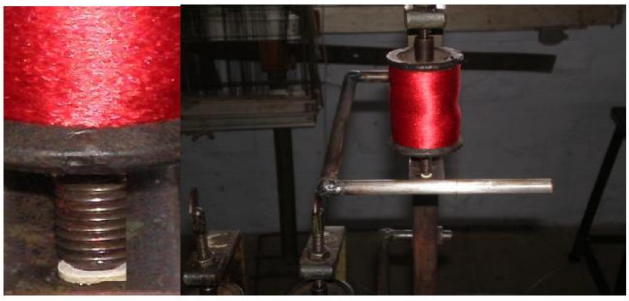
Stage1:

The production and breakage rate is recorded without doing any modification work in machine condition. It was done to ascertain the existing breakage rate and production level.

Stage 2:

The following modification has been done at stage 2

1. Rubber foot for machine legs was put on to arrest vibration
2. The split pulley driving shaft bearings changed to new ones which ensure smooth running of the machine.
3. The driving shaft eccentricity was corrected.
4. The joint of the driving shaft is done by coupler and key arrangement to avoid slippage during running.
5. Porcelain cup was fixed on the creel to ensure free rotation of bobbin red Silk) during rewinding (Figure-6).
6. A pre-Tensioner arrangement is fixed (With tension control adjustment) in between wrapping spindle and creel to maintain constant tension during the unwinding from supply package irrespective of supply package diameter.
7. Perforations were made on the surface (Figure 7) of the wrap spindle fly wheel by which air current dissipation and heat reduction made during running.
8. The lock nut of the hollow spindle (Figure-8) was changed to a butterfly type. This arrangement avoids the use of spanner to dismantle the spindle in case of any malfunction. The spindle can be removed easily by unscrewing the lock nut by hand which leads to a very easy operation.
9. The metal separators have been removed (Figure-9) and replaced by nylon separators, avoiding fluff, fly and oil accumulations during running.
10. The wooden desk was varnished by wooden varnish so that light reflectance was good and ensure good working atmosphere



Porcelain cup has been put on the bottom side for free rotation.

Figure-6 Porcelain cup fixed in creel

Perforation on the flywheel

Figure-7

Butterfly Type

Figure-8-Butterfly type lock nut

Separator Walls

Figure-9 Nylon Separator

Stage 3:

1. A pre Tensioner was fixed in alignment to the hollow spindle centre in between creel and hollow spindle and a post Tensioner arrangement was fixed in between hollow spindle and take up roller. The post Tensioner device helps in maintaining constant tension at take up side irrespective of take up package diameter.
2. The motor pulley key way was corrected and fitted with proper key rod and lock arrangement which in turn reduces jerk of motor pulley during running and ensures proper transmission. After fixing pre tensional & post Tensioner there was a significant improvement in machine efficiency & production per spindle (Figure-10, 11).

Post Tensioner Device

Pre-tensioner device before the creel

Figure-10, 11: Pre Tensioner and Post Tensioner

Stage 4:

The machine speed was increased to 4617 rpm from 4386 rpm (231 rpm increased) and the machine performance was studied.

2.2 Production improvement study

Initially the spindle, delivery package are numbered sequentially. At the start of each study the empty package was weighted and noted according to the spindle number. The driving thread was changed by a new one and all the spindle was driven with equal speed. By doing this the variation of speed between spindles was minimized. The hollow spindle was cleaned, oiled properly by using coconut oil and refitted in proper position. The starting time and ending time was noted for each study. The RH% was noted for every half an hour with the help of hygrometer. The cause for breakage is noted and recorded in the respective spindle in a prescribed format. At the end of each study the delivery package was again weighted by using electronic balance and the weight was recorded in the respective spindle number. The difference between the initial and final weight was calculated and the production in respective spindle was found.

Table No 1 Production results

Particulars	Stages →	1	2	3	4
Expected breaks/Spindle/8 hours		588	360	14.2	9
Production/spindle in Gms/8 Hours		1.6	4.4	6.898	7.2
Waste%		46	18.5	1.5	0.4

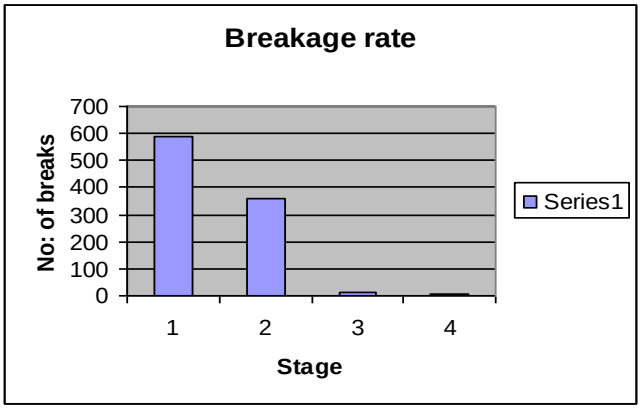


Fig-12: Breakage Rate

From the study the breakage rate was considerably reduced from 588 breaks/ spindle/8 hours to 9 breaks per spindle/ 8 hours.

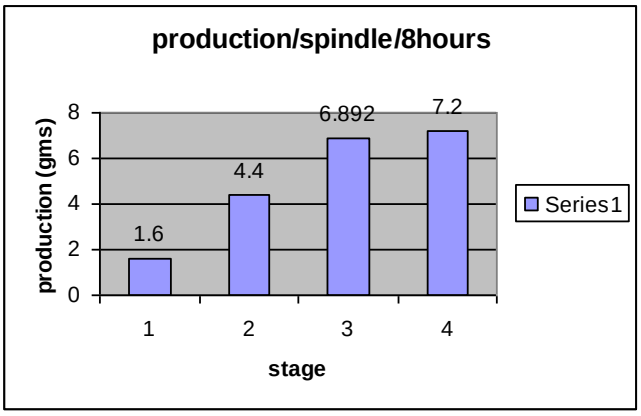


Fig-13: Production details

The production/ spindle/8 hours is increased from 1.6 gms to 7.2 gms because of reduction in breakage rate.

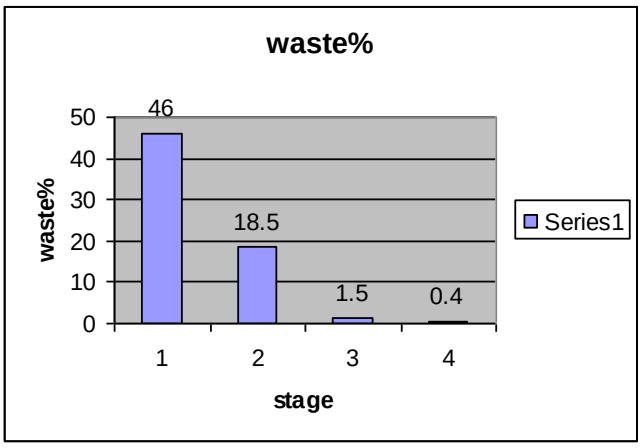


Fig-14:Waste%

The waste % is very much reduced from 46% to 0.4% due to the modification done in wrap spinning machine.

Table No 2 Breakage study in Zari wrap spinning M/C

S.No	Stage	Spindles → / Causes of Breaks	1	2	3	4	5	6	7	8	9	10	Total
1	I	Creel of breaks (red Silk)	1	2	3	2	3	2	3	2	3	2	23
	II			1	1								2
	III				1	1			1		2	1	6
	IV									1			1
2	I	Reel Break (Silver Wire)	5	7	15	10	6	7	12	15	13	12	102
	II		7	11	6	5	13	6	5	7	7	7	74
	III		3	4	7	2	4	16	14	4	4	1	68
	IV		3	3				2	2	2	1	1	14
3	I	Bobbin Exhaust (reel Side)					1						1
	II												-
	III												-
	IV												-
4	I	Silver reel Exhaust			1						1		2
	II		1	1		1							3
	III			2		2	1	1	2	2	1		11
	IV												
5	I	Driving Rope cut			1				1		1	1	4
	II		1		1		1						3
	III		1			1		1	1				4
	IV												
6	I	Reel Entanglement	1		2		2	1	2	1	2	1	12
	II		1	2		1	1		1		1		7
	III			1				1	1				3
	IV		2										2
7	I	Breaks at Take upside		1			1					1	3
	II				1								1
	III					1							1
	IV												
Total breaks		Stage I	7	10	22	12	13	10	18	18	20	17	147
		Stage II	10	15	9	7	15	6	6	7	8	7	90
		Stage III	3	7	8	6	5	19	19	6	7	2	82
		Stage IV	5	3				2	2	3	1	1	17

Table No 3 Production details

Spindle number	stage	Initial Wt gms	Final wt gms	Net gms	Total Breaks
1	I	162.02	163.01	0.99	7
	II	160.20	161.2	1.0	10
	III	160.223	163.642	3.419	4
	IV	157.1	158.5	1.4	5
2	I	153.47	154.06	0.59	10
	II	162.06	162.86	0.80	15
	III	162.069	165.046	2.977	6
	IV	159.9	161.1	1.2	3
3	I	158.63	156.83	0.26	22
	II	154.43	155.53	1.10	9
	III	154.470	157.064	2.594	8
	IV	159.9	161.5	1.6	-
4	I	161.80	162.30	0.50	12
	II	158.20	159.4	1.20	7
	III	158.237	161.371	3.134	6
	IV	154.4	156.0	1.6	
5	I	153.98	154.40	0.42	13
	II	160.80	161.6	0.80	15
	III	161.808	165.100	3.292	-
	IV	155.0	156.7	1.7	-
6	I	162.56	163.06	0.5	10
	II	152.70	154.0	1.30	6
	III	153.748	156.286	2.538	17
	IV	157.3	158.5	1.2	2
7	I	153.32	153.52	0.20	18
	II	161.30	162.55	1.25	6
	III	160.300	162.946	2.646	16
	IV	154.8	156.1	1.3	2
8	I	163.70	163.99	0.19	18
	II	153.98	155.25	1.3	7
	III	153.982	157.332	3.350	2
	IV	158.0	159.2	1.2	3
9	I	159.60	159.80	0.20	20
	II	155.63	155.73	1.10	8
	III	162.562	165.665	3.103	7
	IV	158.5	159.6	1.1	1
10	I	165.62	165.84	0.22	17
	II	163.9	162.05	1.15	7
	III	155.630	158.522	2.892	5
	IV	157.5	158.7	1.2	1

Table No 4 Abstract of production details

Particulars	Stage I	Stage II	Stage III	Stage IV
Total production for 2hrs	4.01 gms	11gms	17.24gms	13.5gms
Waste	3.5 0 gms	2.5gms	0.391gms	0.4gms
Avg production/spl for 2hr	0.40 gms	1.1gms	1.724gms	1.8gms
Expected production for 8hrs/spl	1.60 gms	4.4gms	6.896gms	7.2gms
Total Waste	46%	18.5	2.6%	2.8%
Total Breaks/2hrs/10spindle	147	90	82	90

Conclusion

After the modification to the machine the following advantages are achieved:

1. Due to the poor condition of machine it shows enormous breakage rate. After the modification, the breakage rate was reduced from 588 to 9 breaks/spindle/8 hours.
2. It was found that most of the breaks were occurring in the silver wire reel side (75%). It is suggested that careful flattening of silver wire with optimum tension and pressure with proper lubrication will reduce the breakage rate to a minimum possible level.
3. The slough off and entanglement of the silver wire in reels also cause more breaks and lead to more waste% during running. For this the reels should be wound properly during flattening process with proper tension and alignment. It is also suggested that the reels should be get wound to its 3/4th level only.
4. The plastic reel surface should be of smooth type. The serrations on the surface cause breakage during running.

5. Proper lubrication of wrap spindle (once in every 30 minutes) will reduce the heat and also the breakage rate.
6. Though the productivity is directly proportional to the quality & consistency of the input
7. The RH% of the department should be maintained between 55 to 60% to get maximum productivity and minimize the breakage rate to a optimum level.
8. The quality of the silver wire and the carefulness during flattening process plays an important role in controlling the breakage rate. It is suggested that the flattening of silver wire done with much care up to winding in the reels.
9. The driving belt, which drives the wrap spindle, should be change frequently, because of the slackness in the driving belt causes less wrapping speed and leads to breakage.
10. Workers have to be trained properly on how to operate the machines to get maximum production.

References

[1]. Kimmel, L.B.., and Sawhney, A.P.S " Comparison of DREF-3 cotton yarns produced by varying yarn core ratios and feed rates" Textile research journal 60((12), 714-718 (1990).

[2]. Lord P.R.., "Air jet and friction spinning" Textile Horiz 7(10), 20-24 (1987)

[3]. Menghe Miao, Yan Lai How and Kwok Po Stephen Cheng " The role of false twist in wrap spinning" Textile Research journal 64 (1) 41-48 (1994)

[4]. Lawrence, C.A., Cooke, W.D.., and Susutoglu. M " Studies on Hollow spindle wrap spun yarns" Melliand Textilber.Int 66 (5) 320-325 (1985).

[5]. Behery.H.M.., and Nunes.M.F., "The structure Tensile Properties and Morphology of wrapped yarns" Jouranl of Textile Institute 77, 386-402 (1986)

[6]. Xie.Y. Oxenham.W., and Grosberg.P., " A study of the strength of wrapped yarns, Part-I, Theoretical model" Jouranl of Textile Institute 77, 295-304 (1986)

[7]. Miao.M and Chen.R.Q., " Structural Variations of Hollow Spindle wrap spun yarns" Journal of China Textile University, Edition 8(3), 1-8 (1991)

[8]. Hristina Konova and Radostina Angelova "False-Twister as a yarn formation factor in wrap spinning" Textile Research Journal, 2013

[9]. Georgiev I and Konova H." Experimental investigation of wrap yarns". EMF scientific conference, (ed V Yordanov), Sozopol, Bulgaria, September 2006, pp. 59-71, Sofia: TU