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Short Communication

Application of air-vortex thread in sewing operation

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Attempts have been made to use air-vortex spun yarn of 30s and 40s count as sewing thread by using 2.9% and 5.9% concentrations of lubricant. Yarn strength, elongation, hairiness, dry heat shrinkage, yarn abrasion, snarling of yarn after heat setting, loop strength and knot strength of air-vortex spun sewing threads have been studied. It is observed that the sewing thread made with 5.9% concentration of lubricant performs better in comparison to that made with 2.9% lubrication level. Seam strength and efficiency of different types of seam made by air-vortex sewing threads have also been studied. Flat and lapped seams are found to produce higher seam strength and seam efficiency. Seam strength and efficiency improve with increase in the concentration of lubricant in both 30S and 40S yarn. Sewing performance of threads has also been analysed by testing seam strength, seam efficiency and thread breakage during sewing.

Keywords: Cotton, Polyester, Sewing thread, Seam strength, Vortex yarn, Yarn hairiness

Sewability of fabric depends on the low-stress mechanical properties and sewing thread properties. The polyester textured sewing thread has higher seam efficiency and seam pucker[1]. However, use of cotton sewing thread for synthetic fabrics reduces their life due to poor seam performance[2]. Sewing thread must be designed to meet two fundamental functional requirements, viz sewability of the thread and thread performance in seam. The properties of sewing threads are discussed[3-5] elsewhere in the literature. Good lubrication finish is required to make threads run smoothly on high speed machine, where temperature may reach over 300°C (ref. 6). Fast development in sewing technology and ever increasing demand for diversified uses and applications resulted in development of various types of sewing threads[7]. Selecting the correct size of thread for a particular application is very important to the thread performance during sewing and afterwards in the seam. However, the choice is not always easy. It depends upon many factors, including the seam strength, fabric weight, fabric type, seam type, needle size, and several others[2]. There has always been lot of confusion over the thread ticket number in one way or the other. Ticket number is determined on the basis of unfinished thread and not on the basis of finished thread[7]. The thread breakage is sharp in loop and knot forms due to the presence of high transverse forces on the filaments. In the core-spun threads, the cotton sheath slip easily as compared to polyester sheath[8]. Mechanical properties, such as high strength, high modulus, uniform frictional properties, and resistance to abrasion, are the main requirements for sewing threads[6]. The relation between mechanical properties of sewing thread and seam quality is essential for the manufacturer. Manufacturer can make proper decision in selecting the sewing threads[5] by determining the relation between seam qualities and mechanical properties. One of the major advantages of vortex spinning technology is the high speed drafting. In this system, the drafting unit has to operate at a speed 10 times higher than in case of ring spinning[9-11]. The most outstanding feature of vortex-spun yarns is claimed to be their low hairiness in comparison with yarns spun on other systems[10] . Lower yarn hairiness in vortex-spun yarns resulted in lower yarn abrasion[12]. It was concluded in earlier studies that the number of thin places in vortex-spun yarns is lower than in open-end rotor-spun yarns and higher than in conventional and compact ring-spun yarns[12]. Vortex-spun yarns are better than open-end rotor-spun yarns and worse than ring-spun yarns in terms of the number of thick places and neps. On the other hand, a higher frequency of thick places and neps is observed in 100% cotton vortex-spun yarns when compared with ring and open-end rotor-spun yarns[13]. However, in earlier studies, significant difference in terms of neps [14, 15] was not found. Tensile properties of vortex-spun yarn was also thoroughly investigated by many researchers[16,10]. Singeing improves the appearance of the threads prior to use, since abrasion at the needle eye causes abrasion of yarn surface, resulting in protrusion. Removal of protruding from the surface of the thread during singing reduces abrasion at the needle eye during stitching[2].

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The aim of the present work is to analyse the sewing thread properties at different concentration levels 2.9% and 5.9% of lubricant by using the polyester/ cotton blended spun yarn produced from air-vortex spinning system.

Experimental

The sliver and roving were produced using cotton (fibre length 32 mm and fineness 3.6 micronaire) and polyester (fibre length 40 mm and denier 1) blending with the ratio of 70% polyester/30% cotton. Then these materials were used to produce yarns with count of 30 Ne and 40 Ne from air-vortex spinning system. Hank of the sliver was 0.14 Ne. The single yarn produced from air-vortex spinning system was taken into winding process and then converted as sewing thread. The vortex yarn was conditioned to prevent the snarling of the yarn and to bring zero liveliness. Two vortex single yarns were passed through the machine in parallel winding and combined. Parallel winding prevents the knot formation of the single yarn while feeding single yarn directly into ply twisting machine. Ply yarn twist was set as 14.2 TPI for 30 Ne and 15.36 TPI for 40 Ne in TFO machine. The dyeing was carried out as per the standard process conditions. Finishing process provides lubrication to the yarn that leads to reduction in coefficient of friction. A commercial lubricant "T23" with 2.9% and 5.9% concentration was used in this work. In earlier studies, finishing was carried out on winding machine and the add-on percentage was changed by varying the settings of the machine[17]. In the present study, 2 g of thread was kept in drying oven for 10 min at 110˚C temperature after that the weight was checked. Then the thread was soaked with 100 ml of petroleum ether for 15 min and dried completely. After drying, the thread weight was measured. Lubrication content was determined by using the below following formula:

$$\text{Lubrication content} = \frac{(\text{Original sample weight} - \text{final dried sample weight})}{\text{Original sample weight}} \times 100$$

Tensile strength and elongation were measured in Uster tensorapid tester. Hairiness test was carried out in Zweigle yarn hairiness tester. Dry heat shrinkage test was performed in an instrument at 1 m gauge length with an initial temp of 31°C and final temp of 180°C. Yarn abrasion test was done in yarn to yarn abrasion tester. Number of snarls / 25 cm was measured in snarling test by manual method. Loop strength and knot strength were measured on Instron single yarn tester as per the method followed by Rengasamy and Samuel[8].

By using vortex-spun sewing thread, a plain woven shirt of 110 GSM, 29 EPI and 26 PPI, was produced using Juki DD87007 single needle lock stitch sewing machine. Seam strength was measured according to ASTM D1683, and seam efficiency was determined by following ASTM D5034. Seam efficiency index (SEI) was calculated as the % seam strength by using the following formula:

$$\text{SEI} = \frac{\text{Seam tensile strength}}{\text{Fabric tensile strength}} \times 100$$

Results and Discussion

Properties of air-vortex spun yarn are given in Table 1. It has been observed that, with the increase in concentration of the lubricant, yarn strength increases. This may be due to the reduction in friction between the yarn and improves the load sharing ability of the under stress. The yarn strength value of 30^S air-vortex spun yarns is higher than that of 40^S air-vortex spun yarns. The number of wrapper holds the internal parallel bundle tightly together. These fundamental structural arrangements cause the higher strength value of vortex yarn. The lubricant level contributes to elongation percentage. Here, lubrication level of 2.9% results in higher elongation in the sewing thread. However, in the case of 5.9% lubricant level, the sewing thread elongation is low, and also sewing thread has smooth surface. While sewing, no breakage occurs because of low elongation and smooth surface. The heat generation in the needle during sewing also reduces at lubricant

Table 1 — Yarn properties for 30^S and 40^s count

Property	2.9% Lubricant		5.9% Lubricant	
	30s	40s	30s	40s
Yarn strength, N	840	510	920	640
Yarn elongation, %	16	16	14.5	13
Dry heat shrinkage, %	4	4.2	2.5	3.3
Yarn snarl measure (before heat setting) / 25 cm	12	14.5	6	8
Yarn snarl measure (after heat setting) / 25 cm	4	4.2	2.5	3.3
Abrasion test, rubs	4700	2500	6800	3600
Loop strength, N	50	30	80	55
Knot strength, N	4	3.5	4.2	4.7
Yarn hairiness index	4	3.5	3.1	2.3

level of 5.9%. Sewing thread elongation should be low for sewing purpose. The reason for the lower elongation values in the vortex yarn structure may be due to the decrease or to curb the slippage as a result of better grip by wrapper on the yarn surface, which causes a lower elongation. Yarns have higher shrinkage at 2.9% lubricant level as compared to that at 5.9% lubricant level. Normal ring-spun yarn has twisted structure, which has spring like property and always has a tendency of shrinkage. Vortex yarn has no twisted structure; hence the shrinkage problem is very less in the vortex yarn due to this structural difference. The vortex yarn has lower snarl value than the other yarns due to its yarn structure. The untwisted core fibres contribute to a very low snarling of the yarn. Yarn snarl is low at 5.9% concentration of lubricant because the untwisted fibres are closely folded together with the help of lubrication. Yarn of 40s with 2.9% lubricant has low yarn -to-yarn abrasion. Higher numbers of abrasion cycles are obtained with 5.9% of lubricant for 30s and 40s vortex yarns. The sewing thread should have good abrasion property, because while sewing yarn passes through the needle at high speed, heat generates in the needle and thread gets broken. So, the sewing thread treated with 5.9% lubricant level prevents the thread breakage during sewing and it runs smoothly. The higher loop strength of 30^s sewing threads can be attributed to the higher yarn strength. However, loop strength for both 30s and 40s vortex yarn increases with the increase in concentration of lubricant. The knot strength of a sewing thread is considered as a measure of brittleness of the thread. The knot strength also reflects the performance of the thread after stitching. With increase in the concentration of lubricant, knot strength increases for both 30s and 40s vortex yarns. It has been observed that 40s single yarn has low hairiness in comparison to 30s single yarn, because the wrapper fibres are fully bound on the surface in 40s yarn, resulting in low hairiness. With increase in the concentration of lubricant, hairiness reduces in both 30s and 40s yarn. The wrapped and protruding fibres are locked tightly with increase in the concentration of lubricant and leads to low hairiness.

Four different types of seams, viz. superimposed, flat, lapped and welt are taken in this investigation. Features of those seams are shown in Fig. 1.

In superimposed seam, one fabric is uniformly placed on another fabric and then stitching done. Here, just two layers of fabric are attached together by only one stitch, so the seam strength is very low as compared to other seams.

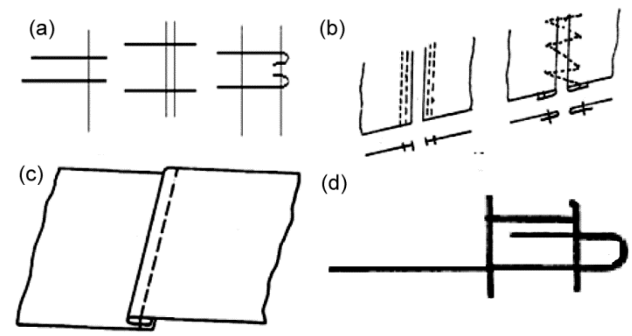

Fig. 1 — Features of (a) superimposed seam, (b) flat seam, (c) lapped seam and (d) welt seam

In flat seam, construction is made by placing one edge inside a folded edge of fabric. There are 2 top stitches in the fabric. In this, a superimposed seam is prepared. One edge is normal and other edge is trimmed half and fold together and then stitch it off. Here, one layer is over edged. In other layer, half trimmed fabric is folded together forming the top stitch. Due to thread and SPI contribution, the strength is high as compared to other seams.

In lapped seam, edges overlap especially a seam in cloth made by extending a cut or folded edge over a cut edge to the width of the seam allowance and stitching in place. Here, only one edge is folded together. Other fabric is in normal mode so the thread and SPI contribution is more towards the folded fabric as compared to that towards normal layer fabric.

In welt seam, one needs to do a superimposed seam. One edge is covered by overlock and other edge trimmed half and just folds it together then stitches it off. Here only the folding of main fabric is contributing, so the strength will be less.

Seam strength results are compared with different seams such as superimposed seam, flat seam, lapped seam and welt seam (Table 2). Lapped seam shows higher seam strength in comparison to other seams with the vortex-spun sewing threads. The reason for this higher seam strength value of vortex sewing yarn is due to yarn structure. The number of stitches per unit length is the main factor which affects the seam strength. Generally, seam strength increases with the increase in stitch density. But when stitch density is too high or the seam breaks by seam slippage, inverse effect on seam strength may happen due to the mechanical damage of the fabric by the needle action in sewing machine. Hence, with higher values

Table 2 — Seam strength

Stitch length, mm	Seam	Seam strength at break, N			
		2.9%		5.9%	
		30s	40s	30s	40s
1.5	Superimposed	262.8	170.2	368.6	201.0
	Flat	440.8	294.7	593.7	363.1
	Lapped	524.3	375.5	580.5	447.8
	Welt	245.8	140.3	314.3	193.4
2.5	Superimposed	201.9	150.6	246.3	157.2
	Flat	415.1	233.1	452.4	341.6
	Lapped	400.0	334.9	514.9	348.3
	Welt	221.6	125.3	252.7	158.2
3.5	Superimposed	187.8	127.6	202.8	138.9
	Flat	361.9	198.2	417.6	241.7
	Lapped	412.7	269.2	448.0	325.9
	Welt	178.8	118.5	210.8	131.6

Table 3 — Seam efficiency

Stitch length, mm	Seam	Seam efficiency, %			
		2.9%		5.9%	
		30s	40s	30s	40s
1.5	Superimposed	42.4	27.5	59.5	32.4
	Flat	71.1	47.6	95.75	58.6
	Lapped	84.6	60.6	93.62	72.3
	Welt	39.7	22.7	50.7	31.2
2.5	Superimposed	32.6	24.3	39.8	25.4
	Flat	67.01	37.6	73	55.1
	Lapped	64.51	54.01	83.1	56.2
	Welt	35.8	20.3	40.8	25.6
3.5	Superimposed	30.3	20.6	32.8	22.5
	Flat	58.4	32.00	67.35	39.0
	Lapped	66.51	43.4	72.3	52.5
	Welt	28.9	19.1	34.00	21.22

of breaking force of the sewing thread there is an increase in the seam strength. Seam strength value is varying for different seams and stitch types. Seam breaks due to the weakening of material and thread as a result of wearing and washing.

Seam efficiency results are shown in Table 3. The retention of strength in a seamed fabric after sewing with respect to the original fabric strength is measured in terms of seam efficiency. Flat and lapped seams perform satisfactorily at all stitch lengths. Seam efficiency improves with increase in the concentration of lubricant in both 30S and 40S yarns. This is due to the reduction in friction between the yarn and the sewing needle as well as increase in mobility. Thread breakage during sewing is also investigated and the results show that it is zero for both 30s and 40s yarns, for different seam types (superimposed seam, flat, lapped, welt), and for both lock stitch and chain stitch types. The may be due to less hairiness level, good strength and smoother thread surface.

It is observed that the sewing thread made with 5.9% concentration of lubricant performs better in comparison to that made with 2.9% lubrication level. Seam strength and efficiency of different types of seam made by air-vortex sewing threads have also been studied. Flat and lapped seams are found to produce higher seam strength and seam efficiency. Seam strength and efficiency improves with increase in the concentration of lubricant in both 30S and 40S yarn. The sewing performance and the breakage rate study shows that there are no breakages during sewing. This indicates the prospect of the use of air-vortex spun yarn as a sewing thread in the garment industry.

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