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Study on characteristics of Air vortex sewing thread and its application

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Abstract - Study have been made to use air-vortex spun yarn of 40s count s sewing thread by using 1%, 3% and 5% 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% concentration of lubricant performs better in comparison to that made with 3% and 1% lubrication level. Sewing performance of threads has also been analyzed by testing seam strength, seam efficiency and thread breakage during sewing. 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. However, use of cotton sewing thread for synthetic fabrics reduces their life due to poor seam performance. Sewing thread must be designed to meet two fundamental functional requirements, viz sewability of the thread and thread performance in seam. Good lubrication finish is required to make threads run smoothly on high-speed machine, where temperature may reach over 300°C. Fast development in sewing technology and ever-increasing demand for diversified uses and applications resulted in development of various types of sewing threads. Selecting the correct size of thread for a particular application is very important to the thread performance during sewing and afterwards in the seam.

***Key Words:** Air vortex yarn, sewing thread, ring spun yarn, spinning methods, sewing thread lubrication, yarn twisting process, air vortex sewing thread, sewing thread application.*

1. INTRODUCTION

Yarn spinning is the process of creating or converting fibre resources into yarns in general. Spinning has been known as a process of transforming raw materials such as cotton and wool into yarns for creating textile fabric or items since a few centuries ago. Ring-spun, rotor-spun, twist-less, wrap-spun, and core-spun yarns are among the several spinning technologies used to create yarns. Ring- spun yarns are the most common way of producing staple-fibre yarns. The oldest of the modern spinning methods is ring spinning. The ring-spinning machine receives the fibre material in the form of roving. The roving's fibre mass is decreased using a drafting device. The inserted twist goes rearward until it reaches the drafting unit's fibres. The fibres form concentric helical pathways around one another.

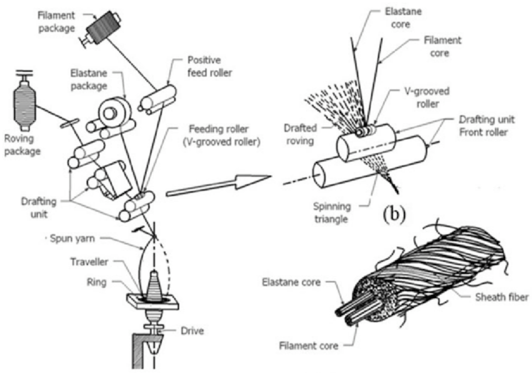

IMAGE 1: RING SPINNING SYSTEM

Under tensile strain, the usual forces experienced by the fibers increase the adhesive forces between them, preventing fibres from flying or slipping past each other. It is the process of drawing out roving to the required yarn count, twisting the fibres with a rotating spindle, and winding the yarn onto a bobbin. These three steps occur at the same time and in the same order. A twist is created by a mechanically operated spindle on which the yarn packet is securely held. The traveller is held in place by a fixed ring that wraps around the spindle. The yarn is drawn under the traveller and then led to the yarn package from the drafting unit. The traveller must cooperate with the spindle in order to wound the twisted yarn on a bobbin tube carried by the spindle. The traveller is transported along the ring by the yarn it is strung with, rather than by any physical force. The traveller spins at a slower rate than the spindle, allowing for yarn winding on the tube. The shape of the yarn packet, known as a Cop or Bobbin, is determined by a regulated up and down movement of the ring. The yarn counts that can be produced by ring spinning technology are the most diverse. Due to its slower production speeds and the additional procedures (roving and wrapping) required to produce ring spun yarns, ring spinning is a rather expensive operation. Ringspun yarns are high-quality yarns that are mostly made in the fine (60 Ne, 10 tex) to medium count (30 Ne, 20 tex) ranges, with a tiny number made in the coarse count (10 Ne, 60 tex). High-quality undergarments, shirting, and towels are examples of end applications. The ring yarn's fibres are very parallel and helical in character, and the fibre arrangement is consistent throughout the yarn's thickness. With no wrapping or looped fibres, the yarn has a compact structure. The self-locked structure is caused by intense fibre migration, which is impacted by the spinning zone's triangular geometry and high spinning tensions. The yarn's remarkable axial strength is due to its unique self-locked structure.

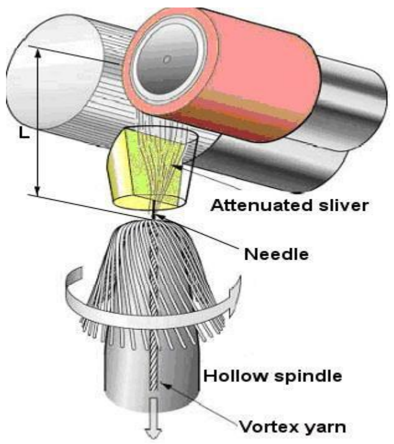

IMAGE 2: PRINCIPLE OF VORTEX SPINNING

Vortex spinning is a yarn-spinning technique that employs an air vortex. The fibres created by these air fluxes have a distinct structure, which gives the yarn a wide range of functions. Vortex spinning uses a four-roller apron drafting method to draught pulled cotton sliver to the appropriate yarn count (fineness). The drafted fibres are then drawn into a nozzle, where they are swirled around the outside of a hollow stationary spindle by a high-speed air vortex. The fibres created by these air fluxes have a distinct structure, which gives the yarn a wide range of functions. Since it is possible to eliminate moveable elements such as the spindle and traveller in ring spinning or the centrifuge in rotor spinning, air-jet spinning systems have been developed.

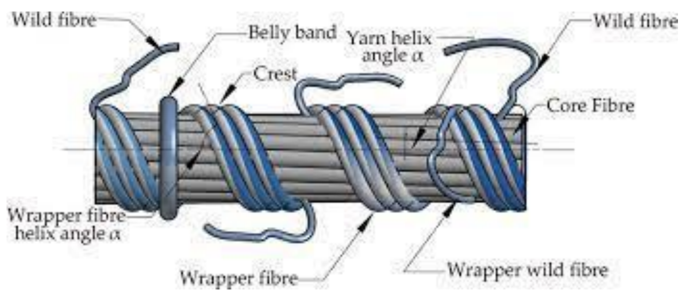

IMAGE 3: STRUCTURE OF VORTEX YARN

The performance of the Murata vortex spinning (MVS) system, which is the newest technology after all investigations of air-jet systems, has been very encouraging, particularly for the ability to spin 100 percent cotton at high speeds (500 m/min) and the yarn structure resembling ring yarns rather than rotor yarns.

Murata vortex spinning (MVS) is based on Murata's current air-jet spinning technology, however it differs from Murata vortex spinning (MJS) in principle due to the geometry of the air-jet twisting device employed. A nozzle block with injectors for swirl flow creation, a needle holder, a hollow spindle, and a guide member make up this air-jet device. A sketched sliver is fed to a four-line drawing system in the MVS system.

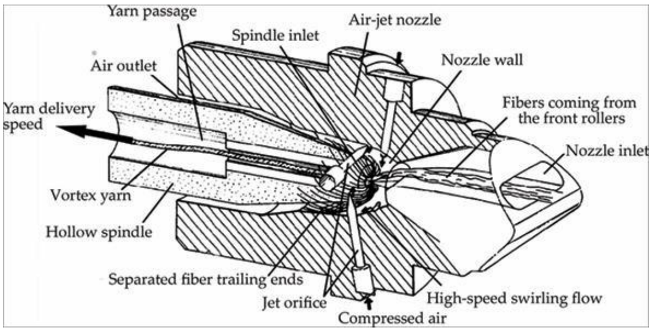

IMAGE 4: NOZZLE BLOCK OF VORTEX SPINNING

The fibres migrate to the air-jet nozzle after exiting the front rollers. The twisting motion tends to flow upward toward the front rollers of the drafting unit, even though the fibres are orientated to be twisted with the pressurized air effect; here, the guide element projecting from the fibre bundle passage prevents this during yarn creation. The vortex chamber generates a high-speed whirling air current into which the pressurized air is injected. The sections that will eventually become core fibres are dragged into the vortex spun yarn path. The higher sections of some fibres separated from the front rollers' nip point, on the other hand, are left open. After the trailing ends leave the nip point, they pass via the spiral fibre passage and, due to the whirling force of the air-jet stream, they twine around the hollow stationary spindle and become the wrapping fibres.

1.1 Materials & methodology

Cotton (fiber length 32 mm and fineness 3.6 micronaire) and polyester (fiber length 40 mm and denier 1) were blended in a 70 percent polyester/30 percent cotton ratio to make the sliver and roving. Then, using an air-vortex spinning machine, these materials were employed to create yarns with counts of 30 Ne and 40 Ne. The sliver's hank was 0.14 Ne. The single yarn created by the air- vortex spinning method was wound and then turned into sewing thread. The vortex yarn was conditioned to eliminate snarling and provide zero liveliness to the yarn. Two vortex single yarns were winded in parallel and joined in the machine. When feeding single yarn directly into a ply twisting machine, parallel winding prevents the single yarn from knotting. In the TFO (Two For One) machine, the ply yarn twist was set at 14.2 TPI for 30 Ne and 15.36 TPI for 40

Ne. The dyeing was done according to the usual process parameters. The finishing process lubricates the yarn, resulting in a lower coefficient of friction. In this study, a commercial lubricant called "T23" with concentrations of 3 percent and 5 percent was employed. Previously, finishing was done on a winding machine, and the add-on % was altered by changing the machine's settings. In this experiment, 2 g of thread was dried in a 110°C oven for 10 minutes before the weight was determined. The thread was then steeped in 100 mL petroleum ether for 15 minutes before drying fully. The thread weight was measured after it had dried. The following formula was used to calculate the lubrication content;

$$\textbf{Lubrication content} = \frac{\textbf{(Original sample weight – final dried sample weight)}}{\textbf{Original sample weight}} * 100$$

2. Results

PROPERTY	3% LUBRICANT		5% LUBRICANT	
	30s	**40s**	**30s**	**40s**
Yarn strength, N	850	520	930	650
Yarn elongation, %	17	17	15.5	14
Dry heat shrinkage, %	5	5.2	3.5	4.3
Yarn snarl measure (before heat setting) / 25cm	13	15.5	7	9
Yarn snarl measure (before heat setting) / 25cm	5	5.2	3.5	4.3

Abrasion tests, rubs	4800	2600	6900	3700
Loop length, N	60	40	90	65
Knot strength, N	5	4.5	5.2	5.7
Yarn hairiness index	5	4.5	4.1	3.3

TABLE 1: YARN PROPERTIES FOR YARN COUNT 30s AND 40s COUNT

3. Conclusion

It has been discovered that as the lubricant concentration rises, yarn strength rises as well. This could be because the friction between the yarn is reduced, which enhances the load-sharing ability of the under-stressed yarn. 30S air- vortex spun yarns have a greater yarn strength rating than 40S air-vortex spun yarns. The internal parallel bundle is held tightly together by the number of wrappers. Vortex yarn has a greater strength value due to these underlying structural arrangements. Elongation percentage is influenced by the lubricant level. In this case, lubrication level of 3 percent leads in more sewing thread elongation. However, when the lubricant level is 5%, the sewing thread elongation is low, and the surface of the sewing thread is smooth.

However, due to the low elongation and smooth surface, no breakage occurs during sewing. At a lubricant level of 5 percent, heat generation in the needle during sewing is also reduced. For stitching, the elongation of the sewing thread should be kept to a minimum. The lower elongation values in the vortex yarn structure could be owing to a reduction in or prevention of slippage as a result of improved wrapper grip on the yarn surface, resulting in a lower elongation. Yarns with a lubricant level of 3 percent shrink more than those with a lubricant level of 5 percent. Normal ring-spun yarn has a twisted structure that has a springy quality to it and is prone to shrinking. There is no twisted structure in Vortex yarn; As a result of this structural difference, the vortex yarn has a far lower shrinking problem. Due to its yarn structure, the vortex yarn has a lower snarl value than the other yarns.

The yarn has very little snarling due to the untwisted core fibers. Because the untwisted fibers are closely folded together with the help of lubrication, yarn snarl is low at 5 percent lubricant concentration. Yarn in the 40s has a minimal yarn-to-yarn abrasion because it contains 3 percent lubricant. For 30s and 40s vortex yarns, 5 percent of lubricant results in a higher number of abrasion cycles. Since the sewing yarn goes through the needle at a rapid pace, heat builds up in the needle, causing the thread to break. As a result, the sewing thread treated with 5 percent lubrication level prevents thread breaking and runs smoothly during sewing. The higher yarn strength is responsible for the higher loop strength of 30s sewing threads. On the other hand, as the lubricant concentration rises, the loop strength for both 30s and 40s vortex yarns increases. The knot strength of a sewing thread is used to determine the thread's brittleness. The knot strength is also a reflection of the thread's performance after sewing. Knot strength increases as lubricant concentration rises for both 30s and 40s vortex yarns. In compared to 30s single yarn, 40s single yarn has less hairiness because the wrapper fibers are entirely bound on the surface in 40s yarn, resulting in less hairiness. Hairiness decreases as the lubricant content rises in both 30s and 40s yarn. With an increase in lubricant content, the wrapped and projecting fibers are held tightly together, resulting in decreased hairiness.

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