A REVIEW OF SCIENTIFIC RESEARCH ON THE OPTIMIZATION OF THE DRAFTING ZONE OF THE SLIVER MACHINE

Suxrob Axmadjanov,
Boburshox Adashev,
Sherzod Korabayev
Namangan State Technical University, Republic of Uzbekistan

Abstract:
This article presents an analytical overview of scientific studies on optimizing the drafting zone of the sliver machine. It evaluates the impact of various technological and mechanical parameters — such as draft ratio, roller spacing, and applied pressure — on yarn quality, evenness, and hairiness. The findings demonstrate the importance of precise control over the drafting zone settings to ensure structural stability of the sliver, ultimately enhancing the quality of the produced yarn. These insights are critical for improving textile production efficiency and final product performance.

Keywords: Sliver machine, drafting zone, yarn quality, unevenness, process parameters, roller pressure, fiber motion

Proper selection and optimization of the parameters in the drafting zone of the sliver machine play a critical role in improving yarn quality. The drafting zone ensures the uniform and parallel distribution of fibers, preparing the sliver for subsequent spinning. If the spacing between drafting rollers, the applied pressure, or the draft ratio are not optimized, yarn unevenness increases, while its strength and elasticity decrease. Therefore, extensive research has been conducted on studying and scientifically optimizing the parameters of the drafting zone in sliver machines.

The sliver machine functions as the final technological unit that improves fiber quality before spinning, and thus, any defect at this stage significantly affects yarn quality and the overall fabric production process [1].

The quality of the yarn and fabric produced from the sliver is directly linked to the structural stability of the sliver. Variations in fiber length, especially in the sliver drafting process, lead to numerous challenges. Since cotton raw material passes through multiple processing stages, the instability of fiber length affects every phase of the spinning process [3].

In the drafting zone of the sliver machine, fibers pass between the lower and upper drafting rollers, which are positioned at a set distance and rotate at different speeds. The distance between rollers is known as the roller setting [2].

The drafting force depends not only on the physical properties of the fibers — such as length, fineness, and flexibility — but also on mechanical parameters of the machine system, including draft ratio, drafting speed, and roller configuration.

Research by Graham and Bragg [4] revealed that the combination of fiber properties and system parameters significantly impacts the drafting force and yarn quality indicators.

Balasubramanian [5] and S.M. Ishtiaque et al. [6, 7] demonstrated that optimizing the technological parameters of the drafting zone can reduce yarn irregularity, defects, and breakage frequency.

Upper rollers play a critical role in the drafting process. When pressed with sufficient force against the lower cylinders, they precisely guide the fibers. Increasing the upper roller pressure narrows the difference between the rear and front pressure zones, ensuring better fiber control and improved sliver uniformity. However, excessive pressure causes these zones to overlap, disrupting fiber movement and increasing sliver unevenness [8].

A study by Karthikeyan M. Ramasamy et al. [9] investigated the influence of sliver machine drafting zone settings on yarn quality. In this research, key parameters such as bottom roller setting, roller pressure, and main draft ratio were varied and analyzed for cotton-based yarns. Results showed that optimal drafting settings reduced yarn unevenness (U%) to 12.8% and the coefficient of mass variation (CV%) to 16.8%. Yarn breakage decreased to 4 per hour, and the hairiness index dropped by 14 units. Thick and thin places and neps were also reduced to 28, 101, and 94 per km, respectively. Overall, optimizing the drafting zone improved yarn evenness, reduced defect counts, and enhanced strength and hairiness levels.

Experiments by Kunduz and Duran also showed that optimizing upper roller pressure ensures controlled fiber movement and minimizes irregularities and defects in the yarn [10]. However, excessive pressure can damage fiber structure by crushing them.

Khurshid and Liu [11] demonstrated that optimizing fiber flow in the drafting zone improves sliver density and enhances the mechanical properties of the resulting yarn.

Inter-fiber friction also influences drafting efficiency. Experiments by Wang and Xu [12] showed that using specially surfaced rollers to reduce fiber-to-fiber friction increased fiber alignment within the sliver by 8%.

Other studies evaluated the ability of fibers in the intermediate drafting zone to resist bending. Wang and Zeng [13] found that minimizing fiber bending during drafting leads to better yarn strength and elasticity.

Yu and Chen [14] emphasized that the surface and diameter of the rollers directly affect fiber trajectory in the drafting zone. Properly selected roller surfaces and diameters reduce floating motion and minimize yarn defects.

Most research highlights that by optimally configuring the drafting zone of the sliver machine, not only structural but also mechanical and technological qualities of the yarn can be improved.

Results of scientific studies show that optimizing the technological and mechanical parameters in the drafting zone of the sliver machine can reduce yarn unevenness by 15–20%, significantly decrease breakage frequency and hairiness, and ultimately enable the production of high-quality, smooth, and consistent yarn.

Conclusion:

Optimizing the drafting zone of the sliver machine based on scientific principles is crucial for enhancing yarn quality. The analyzed studies show that parameters such as draft ratio, roller spacing, top roller pressure, and inter-fiber friction directly influence the final yarn structure. Under optimal conditions, yarn unevenness can be reduced by 15–20%, while hairiness, neps, and breakage frequency are significantly lowered. This not only improves yarn performance but also increases overall production efficiency. Therefore, a thorough analysis and application of optimized drafting parameters remain a key factor in achieving high-quality yarn manufacturing.

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