WEAVING SIZELESS COTTON YARNS - A PROGRESS REPORT (#1)

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Abstract

This is a summary of the work thus far done on a new ARS-CRIS project entitled "Development of a new wholesome technology for weaving cotton yarns without, or with reduced, traditional warp sizing." To explore "sizeless or reduced-size weaving," we have prepared an exhaustive, 3-prong research plan with a focus on the following objectives:

1. Without or with reduced traditional warp sizing, try to solve yarn-related problems (such as low abrasion resistance, excessive hairiness, inadequate tensile properties, and excessive twist-liveliness, etc.) that are currently addressed by the use of conventional warp sizing.
2. Try to modify the weaving machine and process to minimize the yarn abrasion, tension fluctuations, torture and, hopefully, failures during weaving.
3. Try to develop a fundamental understanding of the underlying mechanism(s) of the warp yarn failure/breakage during weaving, so that we can develop new approaches to manipulate yarn properties and preparation and thus minimize the yarn failures in weaving both the conventionally-sized yarns and the proposed sizeless or reduced-size yarns.

So far, we have spun rotor open-end cotton yarns of excellent quality, using combed Acala cotton. This was purposely done to try to attain desirable yarn propertties that would solve, to some extent, some of the anticipated problems of sizeless weaving. To verify our new hypothesis on the mechanism of warp yarn breakages during weaving, we have prepared a loom beam of reportedly uniform and consistent yarn tension, taking appropriate steps and precautions in the spinning, winding, warping and beaming operations. We are awaiting delivery of certain specially finished reed and heddles to commence preliminary weaving trials with a conventionally sized warp and an equivalent sizeless warp.

Based on the above premises, we either have conducted or are in the process of conducting research to attain the following specific objectives to solve "anticipated problems" in weaving size-free cotton yarns:

Yarn-Related Objectives

a. Minimize yarn hairiness and improve yarn tensile properties and their uniformities by producing a rotor OE-spun yarn, using combed Acala cotton which has its approximately 10% short fibers removed.
b. Maximize yarn abrasion resistance by improving yarn structure (controlling fiber migration) and construction (using different TMs) and by lubricating the yarn surface with a suitable lubricant (moisture, vegetable oil, paraffin wax (~0.3% add on)).
c. Minimize yarn twist-liveliness by setting the yarn torque by means of an ordinary boiling-water/steam treatment, containing one percent, by volume, Triton X-100, a non-ionic, surface-active, emulsifier (a wetting agent and a detergent), prior to beaming the yarn on a "modified slasher."

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Weaving Machine and Process Related Objectives

Minimize yarn abrasion and tension fluctuations during weaving by:

- using Teflon-, chrome-, or ceramic- coated heddles, reed and drop-wires. [For quite some time, we had on request Teflon coating of certain critical loom components. As soon as we receive the specially coated materials, we shall try to weave the sizeless cotton warp that has already been prepared].
- using redesigned heddle eyes, perhaps by having a thicker eye profile that is less prone to trap the yarn twist convolution and cause excessive yarn abrasion.
- uniformly moistening warp sheet on the loom by encasing the sheet with a box where it is easier to control humidity precisely; or by maintaining relatively higher RH and temperature (~85% and 80F, respectively) in the weave room.
- devising a method to evenly wet the warp yarns with water alone or with a carefully selected solution of environmentally benign additives at or before the back rest in a controlled manner so that the degree of wetness is uniform and controlled. A simple drying device at or near the cloth fell should ensure that the yarn has normal regain values as it is woven into the cloth or immediately thereafter prior to the cloth winding on to the cloth roll. Of course, this may require that the areas (loom parts) in contact with the wet yarn are protected against any corrosion.
- exploring the possibility of plasma coating of heddles with an appropriate material that acts as a permanent or semi-permanent lubricating agent.
- using a full width temple, which may effectively reduce the fabric length involved in the beat-up and hence permit the required amount of beat-up force to be developed over a smaller cloth fell displacement. This should reduce the yarn peak tension during beat-up, which should reduce the yarn rubbing in the heddle eye.
- adopting appropriate loom timings and settings, especially with regard to the shed formation (size) and timings (early/late) at the time of beat-up.
- manipulating initial loom speed and cloth pick density.

Fundamental Understanding of the Yarn Failure During Weaving

Because of the unique mechanisms of loom "warp let-off" and "cloth take-up," it is hypothesized that inherent tension variations of individual yarn strands on a loom beam probably are a major cause of the (warp) yarn failures during weaving. Thus, to minimize tension variations and inconsistencies of individual yarn strands on a loom beam (warp sheet), we have adopted certain novel yarn production and preparation techniques to monitor and even control individual yarn tensions during spinning, winding, warping, beaming and weaving.

Results

1. Rotor open-end spun yarns of combed Acala cotton and of different twist factors have been produced for the first time at SRRC. Based on the preliminary test results available, the yarns have excellent tensile properties and their uniformities, which are essential for size-free weaving.

   In fact, the yarns are even stronger than the conventional typical carded cotton ring spun yarns which generally are almost 20-30% stronger than equivalent open-end spun yarns. Also, the yarns have minimum hairiness. No protruding fibers longer than ½" (the hairiness threshold for good weaving on shuttle less machines) were observed. Frankly, the greige yarn tests so far have exceeded our expectations. Table I shows the yarn's tensile and evenness characteristics.
2. The warp yarns intended for the size-free study have been wound, warped and beamed (without traditional sizing) with reportedly

consistent individual yarn tension of about 12-15 grams. As stated previously, we are awaiting delivery of certain specially finished loom components such as reeds and heddles.

3. The various yarns produced with different TM's were tested for their subjective and objective abrasion resistance. Preliminary results indicate that the subjective abrasion resistance varies with the TM (i.e., the 5.25 TM gives the highest abrasion resistance and the 4. 5 TM shows the least), whereas the abrasion resistance determined by the so-called objective method does not appear to significantly vary with the various twist multiples investigated.
4. Preliminary results of a cooperative study with the Leeds university indicate that:

    - the wetted yarns in a yarn abrasion test show an increase of about 25% in number of cycles before rupture, compared to the normally conditioned yarns.
    - Installation of a full-width temple on a loom reduced the mean warp tension by 17%, which should considerably assist "sizeless" weaving. Obviously, there are several parameters that need to be taken into consideration before any conclusive results can be drawn from these very preliminary investigations.

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Reference

Sawhney, A.P.S., et al. Preparation and weaving of cotton yarns without the traditional warp sizing --- some new concepts. Proc. Beltwide Cotton Research Conferences, National Cotton Council,. pp. 820-827. 2000.

Table 1. Yarn Properties.

Nominal Size	= 30 tex (OE)
Mean Tenacity at Break	= 17.52 (Std. Dev. 1.05) g/tex
Average Breaking St.	= 485.5 (Std. Dev. 29.1) g
Mean Strain at Break	= 8.2 (Std. Dev. 0.53) %
C. V. of Unevenness	= 12.4%
Imperfections:	
Thin Places (-50%)	= 2/1000 yds.
Thick Places (+50%)	= 5/1000 yds.
Neps (200%)	= 2/1000 yds.