MINIATURE SPINNING AS A FIBER QUALITY ASSESSMENT TOOL

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Abstract

Miniature spinning has long been used to assess cotton varieties in a timely manner. It has been an accepted fact that the quality of miniature spinning is less than optimal, but that it allows a direct comparison between cottons during varietal studies. Recently, researchers have made processing improvements to the traditional miniature spinning process which allows for small samples (less than 100 grams) to be processed quickly while producing yarn qualities that approach commercial-scale textile processing traits. Full-scale carding and drawing equipment was modified to produce optimum quality textile products. Fiber quality changes may be tracked through opening, carding, and drawing as the fiber is processed into ring spun yarns. Yarn testing methods have been investigated to move beyond the traditional practice of using skein break data only to compare varieties.

Introduction

Spinning trials are an important tool for the assessment of fiber quality. Miniature spinning, usually thought of as less than 1000 g lots of cotton, is not a new concept. The Shirley Institute developed a mini-processing system using 42 g of lint in the 1950s (Platts Bulletin, 1959). Parallel to the Shirley Institute development, the USDA Agricultural Marketing Service (AMS) developed a 100 g processing system (Landstreet, et al, 1959). The AMS revised the system into a 50 g spinning test for use in the National Cotton Variety Trials over the next several years (Landstreet, et al, 1962). The current state of the art in mini-scale processing did not advance much until recent work at CSIRO to develop a 170 g spinning system (Long and van der Sluijs, 2008). An emphasis on breeder support and rapid fiber quality assessment techniques has renewed interest in the mini-scale processing work at the USDA.

The Southern Regional Research Center of the USDA-Agricultural Research Service was home to some of the original AMS mini-processing equipment; however it was destroyed during Hurricane Katrina in 2005. The Cotton Quality Research Station at Clemson, SC, also a USDA-ARS location, also contains some of the original AMS mini-processing equipment. A joint effort was begun between the two locations to revitalize mini-scale processing and to refine the techniques using modern textile processing technology to enhance the yarn quality produced by the small-scale systems.

Materials and Methods

The Shirley Institute system utilizes a mini-card which is also used in the modern thermodetector method for measuring cotton stickiness (Hequet and Abidi, 2006). The mini-card consists of a small card cylinder with fixed flats that provide minimal removal of material during carding. The system also contained a small-scale drawframe for conversion of card web into sliver and the resultant sliver was breaker and finisher drawn on the same frame. The final piece of the system consisted of high draft ring spinning frame which directly converted sliver into yarn.

The AMS 100g and 50g systems utilized a modified picker to open and coarsely clean cotton samples. The samples were processed on a modified Saco Lowell Model 100 commercial size card. The card was fed a picker lap from a narrow tray and produced card web collected on a collection drum at the head of the card. The revolving flat chain was partially removed and replaced with granular card plates. The resulting card was composed of half revolving flats and half card plates to reduce loss of material during carding. A small-scale drawing frame was used to convert card web into sliver and produce finisher sliver in a manner similar to the Shirley Institute method. Like the Shirley method, yarn was produced using a sliver-to-yarn ring spinning frame.

The CSIRO method combines use of the Shirley mini-card, a mini-drawframe and full-scale textile processing equipment. Multiple doffs are processed on the mini-card and converted into sliver on the mini-card. The mini-drawframe slivers are used as doublings on a full-scale drawframe for the production of breaker and finisher sliver. The finisher sliver was converted to roving on a commercial roving frame and the resultant roving was spun into yarn on a conventional ring-spinning frame.

The SRRC work borrows elements from each of the prior techniques. A SpinLab laboratory Opener/Blender was employed to open and coarse clean the ~60g cotton samples. A Saco Lowell Model 100 card was modified to accept a narrow feed tray of pre-opened cotton (Figure 1 and 2). The card was also modified to collect card web on a collection drum taken from the original AMS system (Figure 3). The lickerin speed and wire was optimized to provide an open and uniform sample to the card cylinder while imparting minimal damage to the fibers. A commercial drawframe was modified with a variable speed drive, purposely selected roll coverings, and a modified crush roll to convert card web into sliver and draw the resulting sliver into breaker and finisher slivers. The finisher sliver may be converted into rotor spun yarns on a conventional open end spinning frame or ring-spun on the Shirley Institute high draft sliver-to-yarn spinning frame.

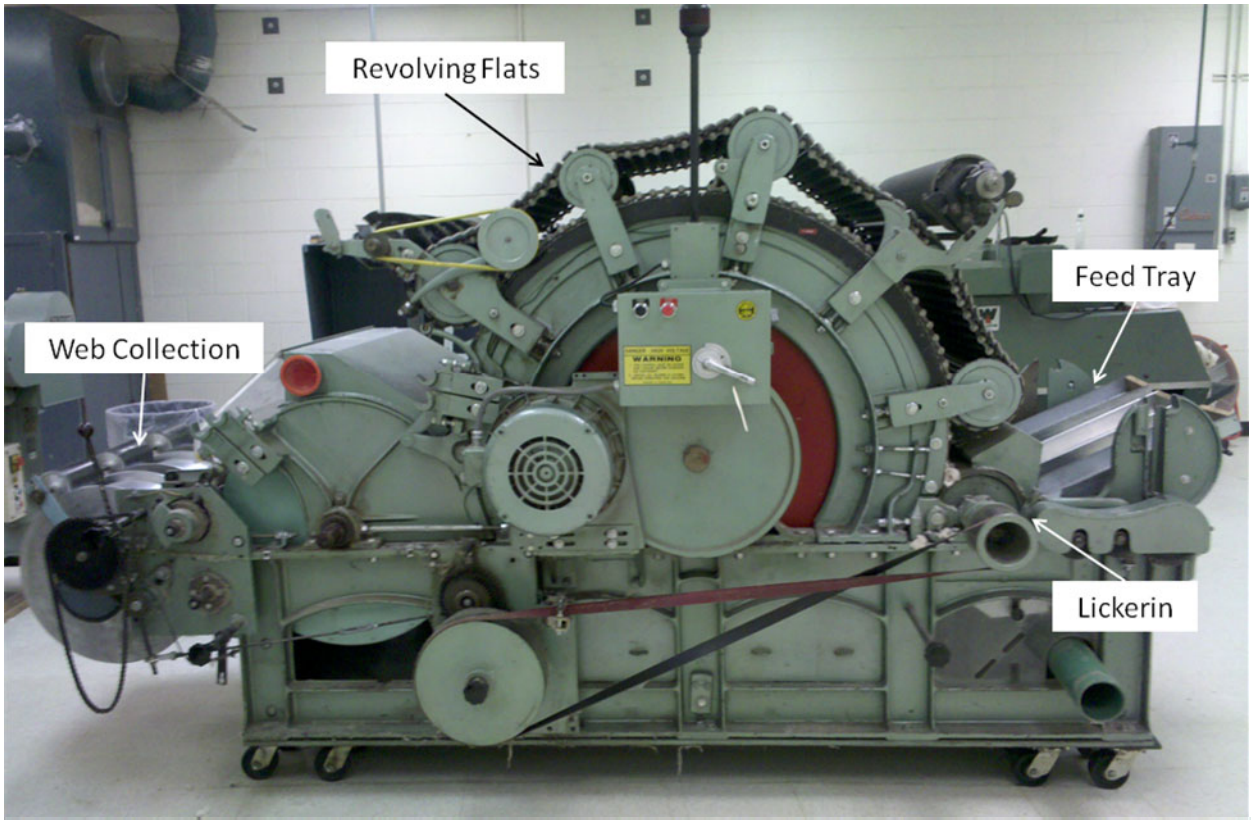

Figure 1. Modified Saco Lowell model 100 card

Figure 2. Tray feed system on mini-scale equipped card

Figure 3. Card web collection system on mini-scale equipped card

An additional aspect to the SRRC work is that of fabric formation. The mini-scale production of yarns can be further processed into either circular knits on a Lawson Hemphill sample knitter or narrow woven fabrics on a CCI Sample Loom. A single lot of approximately 60 grams of fiber allows for woven fabrics to be produced on a common warp, while multiple doffs from the card may be combined to allow 100% warp and fill fabrics to be produced when about 500g of fiber is processed.

The use of approximately 60 g of fiber allows for sampling to be performed during processing assessing the changes in quality during the conversion from raw cotton to finished textile goods. AFIS testing is performed on samples taken from the raw stock, after opening, card web, and finisher sliver.

Standard protocol employed is to produce 2 bobbins of Ne 22/1 ring spun yarns per fiber sample. This protocol yields in excess of 300 m of yarn per package. Testing of the yarns consists of a conventional skein break and 20 single end strength tests. The use of yarn uniformity testing is being explored.

Discussion

The results from miniature scale processing are not intended to replace larger-scale or full-scale textile processing. Miniature processing is intended to indicate which samples are of "good" or "poor" quality so that a large number of samples such as a breeder trial may be narrowed to a more manageable level for larger-scale trials.

In one experiment, 18 samples were processed on both miniature-scale and commercial-scale equipment at SRRC. These 18 samples represented 3 varieties, 2 ginning treatments, and 3 replications. The 18 samples were processed into the same yarn count and subjected to the same testing protocols for both processing scales. Although the actual values do not compare, when ranked both processing scales ranked in the same order +/- 1 position for 16 of the 18 samples. All of the samples ranked within the same order +/-2 positions.

Summary

Miniature-scale processing is still relevant more than 50 years after the idea was first executed. The need for an efficient method of selecting samples for larger-scale processing is relevant today as the demand for time and cost-efficient sample processing is increasing and research and development resources are being reduced. The utility of miniature-scale processing can be increased by leveraging modern technology to expand the products normally produced by miniature-scale processing. The production of rotor spun yarns and fabrics allows miniature-scale processing to provide information which is relevant to the modern textile world.

Disclaimer

The use of a company or product name is solely for the purpose of providing specific information and does not imply approval or recommendation by the United States Department of Agriculture to the exclusion of others.

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