GINNING PERFORMANCE OF FELT AS COVERING FOR ROLLER GIN ROLLS

S.E. Hughs
Supervisory Agricultural Engineer
M. N. Gillum
Agricultural Engineer
USDA, ARS
Southwestern Cotton Ginning Research Laboratory
Mesilla Park, NM

Abstract

The covering or "packing" used for rotary-knife roller gin rolls is very important to the operation of the gin stand and is a major expense item for a commercial roller gin plant. Finding materials that enable faster ginning, wear longer, and are more economical while maintaining fiber quality is an important roller ginning research item. A research project was performed at the Southwestern Cotton Ginning Research Laboratory to compare the performance of a felt material (100% wool) to the conventional fabric and rubber packing. The felt packing wore well, ginned at a reasonable rate, and maintained fiber quality. However, the ginning rate coupled with the cost of the felt packing is not enough to warrant changing from the conventional packing being used in the industry. Further research is required to identify other materials that might be good alternatives to the current packing.

Introduction

Extra-long staple (ELS) Pima cotton production in the U.S. for the 1998-99 crop year is forecast to be 432,500 bales (Cotton's Week, Dec. 11, 1998). The total U.S. Crop is predicted to reach 13,453,000 bales for this current crop year. While comparatively small in production in comparison to upland cotton, the ELS crop is economically important to the states of Arizona, California, New Mexico, and Texas where Pima is produced. ELS cotton fiber is of high quality, particularly length and strength, and brings a significantly higher price than upland cottons grown in the same regions. Essentially all Pima cotton produced in the U.S. is ginned on roller gins. Roller gins are used in order to better preserve the fiber quality of the ELS cotton. Many studies have shown that roller ginning, as compared to saw ginning, produces longer fiber, less short fiber content, and fewer neps (Hughs and Leonard, 1986, and Hughs and Lalor, 1990). Because of these cotton fiber quality factors, ELS cotton will continue to be processed on roller gins in the U.S. for the foreseeable future.

There are several manufacturers of roller gins in the U.S. While the gin stands of the various manufacturers differ in design and operational details, they all possess a cylindrical ginning roll. The rolls are approximately 16 in. in diameter and are covered with a laminated fabric and rubber packing material. The roll surface and the stationary knife are the heart of the modern rotary-knife roller gin stand. The ginning point where the knife and roll touch is the main wear point of a roller gin. It is at the ginning point that the fiber and seed are separated, heat is generated, and the stationary knife and the roll packing are abraded away. It is necessary to routinely replace the packing on gin rolls, because of the packing being worn away to the point that the packing is gone. Replacement of packing rolls and stationary knives is a significant expense in the operation of a roller gin plant. The condition of the packing roll and the type of packing material used has a big effect on the ginning performance of a roller gin stand in terms of pounds of fiber ginned per unit time.

The material used to cover the roller gin roll has been an ongoing research item, because of its cost, relative frequency of replacement, and its importance to the ginning performance of the roller gin stand. Prior to 1940, most of the ginning rolls in the U.S. were covered or wrapped with walrus hide. With the advent of the high-capacity, (rotary-knife) roller gin stand, the potential ginning rate was increased significantly and the roller material wear-life became a limiting factor (Gillum, 1974). The rate at which cotton can be ginned is related to the roller-to-stationary-knife (RSK) force and roller surface speed. Assuming other gin adjustments are in a reasonable range, increasing RSK force and roller surface speed increases the rate at which cotton can be ginned. These increases cause an increase in roller temperature and roller wear rate. The roller material's resistance to temperature and abrasion, its energy consumption (work required to gin a pound of lint), and ginning rate potential (pounds of cotton ginned per unit of time at maximum practical feed rate) are factors in an economic balance between long roller life and high ginning rate.

With the above factors in mind, Gillum (1974) tested the ginning performance of a number of potential materials for covering gin rolls. Materials tested included leather, fabric and rubber composites, cotton, rubber, rubber and cork composites, and ethylene propylene. It was determined that the softer and rougher materials generally required less work to gin a pound of lint. Of the materials tested, fabric and rubber composite covering materials were superior to all other types tested in ginning rate potential and amount of energy consumed. Hardness was also important with a type DO durometer hardness of about 56 being the optimum for the materials tested.

Since the above work was completed, the U.S. roller ginning industry has used almost exclusively a fabric and rubber composite roll packing. The only real change has been an improvement by manufacturers in the construction/curing process, which improved the uniformity of the product, and a change in the construction

Reprinted from the *Proceedings of the Beltwide Cotton Conference*
Volume 2:1461-1463 (1999)
National Cotton Council, Memphis TN

of the roll core itself from wood to steel covered with a vulcanized rubber base. These improvements, along with some small gin stand design changes have improved individual roller life. Early rolls would gin approximately 200 to 300 bales before having to be replaced and recovered because of wear. Current rolls will gin as many as 1000 to 1200 or more before having to be recovered. Even with the current roll life, there is still a need to find materials capable of even longer roll lives and/or faster ginning rates in order to further reduce ginning costs per bale.

This report details a preliminary research project that investigated the use of felt (made of 100% wool) as a covering for roller gin rolls.

Materials

The study was a cooperative project by the Southwestern Cotton Ginning Research Laboratory, Corcoran Machine Works, Corcoran, CA, and Semi-Tropic Cooperative Gin Inc., Wasco, CA. A felt material supplied in strips of several feet in length with a cross sectional measurement of approximately 7/16 by 1 and 1/16 in. was wrapped in a conventional manner around the core of a roll for a Continental Phoenix Rotobar roller gin stand. The average hardness of the test roll surface after wrapping was approximately 20 (type DO durometer scale). The control roll was wrapped with a conventional fabric and rubber material that had been supplied by Continental and had an average hardness of 42 on the DO scale. The test cotton was Pima S-7 that had been grown and harvested in the Mesilla Valley of New Mexico under standard production practices.

Methods

The control roll was already broken in by ginning cotton over a period of time. The control roll was removed from the gin stand, and the test roll was installed in its place. The equivalent of approximately 2 bales of seed cotton was processed over the felt wrapped roll to break it in. During this break in period, various air pressure settings were tried on the cylinders used to engage the ginning roll with the stationary knife to determine if there was an optimum setting. Air pressures used in the field with the conventional roll on this model roller gin stand vary from 90 to 120 psi depending on the operator's preference. It was observed that the tip of the stationary knife tended to "dig in" to the roller surface an excessive amount at the standard setting and higher knife pressure. Probably because the softer material allowed more deformation of the roller surface during operation under pressure. The stationary knife was adjusted or rotated away from the roller surface so that there was approximately 0.005 in. clearance between the knife blade tip and the gin roll when operating pressure was applied. Other than this adjustment, all other gin stand settings were maintained to factory specifications.

The performance of the two roller covering materials was the variable being tested. Therefore, all other variables were maintained constant. Ginning roll and rotary-knife speeds were maintained at approximately 140 and 400 r.p.m., respectively, and air pressure to the cylinders at 90 p.s.i. throughout the test. Each gin roll test was replicated four times using approximately 330 pounds of seed cotton per ginning lot. The laboratory roller gin stand was equipped with an automatic ginning control that was utilized for all test replications. Temperatures of the ginning rolls were monitored with a hand-held IR sensor throughout the test and the maximums recorded. All pertinent process times and weights were recorded. Seed cotton samples were taken at the suction pipe, and ginned fiber samples were taken after the gin stand and after lint cleaning for fiber property analysis.

Results and Discussion

Table 1 shows the average ginning data for the gin roll comparison. The ginning rate was significantly different by approximately a half bale per hour in favor of the conventional roll. Both numbers were generated under computer control; however, it was apparent from the amount of carryover during the test that the process control parameters used for the standard gin roll were not optimum for the test roll. The small amount of seed cotton on hand did not allow for experimental development of different control parameters. An adjustment was made to the control algorithm for the standard roll to operate the gin stand with the same amount of seed cotton carry over for both rolls. This adjustment was visually evaluated and subject to human error. Part of the ginning rate difference shown in Table 1 was probably due to the need to have better and different control parameters for the experimental roll. Never-the-less, the felt roll probably would not have equaled the ginning rate of the standard control roll at the 140 r.p.m. roll speed.

Speeding up the roll and/or increasing the stationary knife pressure are means of increasing the ginning rate of a roller gin stand. Because of the softness of the felt material, it was decided not to increase the knife pressure. Increased pressure would probably have resulted in greatly accelerated shedding of roll material and roll wear due to the mechanical action of the knife. An increase in roll speed to increase ginning rate might be possible if the roll surface temperature could be controlled at a reasonable level. It was observed during the test that the felt roll tended to have a lower maximum temperature than the control roll. It also cooled off much quicker after the test run, indicating that its thermal properties are different than the fabric and rubber control packing and may stand higher roller speeds without excessive heating. This would have to be taken into account in any future development work.

Table 2 shows the average HVI class data for the Pima cotton that was processed over the two different rolls. The

Rd for the fiber ginned on the felt roll was significantly different than that processed on the control. The higher Rd indicates that the cotton ginned on the experimental roll is brighter than that processed over the control roll. All other HVI measurements are essentially the same. It is not known why the same seed cotton processed over the test roll would be brighter than that ginned on the control roll.

Table 3 gives the average AFIS data by weight. There were no significant differences between treatments for any of the fiber properties measured. There may be a slight tendency for the cotton processed over the felt roller to be shorter, but any small effects on fiber length is not at all clear from this test.

After the laboratory tests were completed, the test roll was shipped to Semi-Tropic Coop Gin and installed and operated for a period of time. The roll ginned cotton over several days without undue wear or other apparent problems. However, it appeared that its ginning rate was somewhat less than the other stands being operated and was later removed from service.

The fiber ginned at the Southwestern Cotton Ginning Research Laboratory was sent to the USDA, ARS, Clemson Pilot Spinning Laboratory for evaluation for spinnability as well as evaluation for contamination. One of the questions concerning the use of an alternate roll covering material such as wool is: does it contaminate the cotton fiber as it wears during the ginning process? Dyeing problems are of particular concern and will be checked at the Spinning Laboratory and reported later. Another question is: will a felt packing of higher durometer (more firm) perform better and have a higher ginning rate? Higher durometer felts are available as well as some possible new rubber formulations that would be of interest for later work.

Conclusions

A roller gin roll covered with a felt packing was able to gin Pima cotton at a reasonable ginning rate. The rate was not equal to the standard control roll, but other more firm felt materials might perform better. There appeared to be no adverse effects to raw fiber quality from the use of a felt covered roll as opposed to a fabric and rubber packing material. Further work is planned to investigate other materials.

Acknowledgments

The authors would like to acknowledge Randy Pierce of Semi-Tropic Coop Gin, Inc, Wasco, CA and Darin Gilbert of Corcoran Machine Works, Corcoran, CA for their cooperation in this research project.

References

Cotton's Week, Dec. 11, 1998. USDA raises US crop estimate to 13.45 million bales. National Cotton Council of America, Memphis, TN.

Gillum, M. N. Properties of roller gin roller covering materials. 1974. Technical Bulletin No. 1490. Agricultural Research Service, USDA.

Hughs, S. E. and W. F. Lalor. 1990. Fiber and yarn effects of roller versus saw ginning. Proceedings of the Beltwide Cotton Production Conferences. 542-543.

Hughs, S. E. and C. G. Leonard. 1986. Roller versus saw ginning of long-staple upland cotton. The Cotton Gin and Oil Mill Press 87(20):8-10.

Table 1. Average Ginning Data.

Roll Type	Ginning Rate (Bales/h)	Turn Out (%)	Max. Roll Temp. °F
Felt	1.13	35.0	199
Control	1.64	35.2	202
OSL	0.0012	NS	NS

Table 2. Average HVI Fiber and Trash Data.

Roll Type	Color Grade	HVI (Rd)	HVI (+b)	HVI Length	HVI Uniformity	Total Shirley (%)
Felt	2	71.0	12.2	136.2	85.5	1.5
Control	2	69.8	12.3	137.0	85.5	1.5
OSL	NS	0.0025	NS	NS	NS	NS

Table 3. Average AFIS Data.

Roll Type	Length (In.)	UQL (In.)	Short Fiber (%)	CV (%)	Neps (Count/g)
Felt	1.16	1.42	5.1	32.8	109
Control	1.18	1.43	4.8	31.9	107
OSL	NS	NS	NS	NS	NS