POWER ROLL 2007: A FIVE YEAR SUMMARY

James Askew
Servico Gin Co.
Courtland, AL
Greg Holt
USDA-ARS
Lubbock, TX

Abstract

The powered roll gin stand (PRT – Powered Roll Technology) was first tested in a field application on seed cotton during the 2002 ginning season at Servico, Inc., Courtland Alabama. During the 2003 season, Servico installed and operated PRT stands in all three lines. In subsequent years, mechanical improvements have been made to the stands, improving their mechanical integrity and performance. In addition to maintaining the excellent gin turnout gains and fiber quality characteristics obtained in 2002 and 2003, the PRT stands have proven to be highly beneficial from a production standpoint as well. Average daily gin production rates increased from 631 to 775 bales per day from the 2002 to the 2007 gin seasons, respectively. Additionally, gin labor costs per bale decreased from an average of $3.42 per bale during the four seasons prior to the 2002, PRT test season, to $2.66 per bale during the five seasons since 2002. Furthermore, fiber and seed quality tests were conducted for comparison of plastic, steel and aluminum power roll flaps. The flap material tests showed few statistically significant differences for fiber quality parameters.

Background

The powered roll gin stand (PRT) was initially designed for the removal of cottonseed tail fibers. This was necessary to improve the flow characteristics of cottonseed after being coated with corn starch in the Easiflo process. The success of the cottonseed version of PRT led USDA-ARS researchers at the Lubbock gin laboratory in Lubbock, Texas, to test the viability of the technology on seed cotton. The results of these tests indicated improved fiber quality parameters and turnout (Laird, et al., 2002). The laboratory tests were conducted on a modified Continental 90 saw gin stand with 12 inch diameter saws. The modifications included the installation of narrower ribs and increasing the number of saws to 116. The positive results led to the agreement with Servico, Inc. to install and operate the first commercial PRT gin stand during the 2002 gin season.

The PRT gin stand develops and maintains a seed roll by the interaction of a counter-clockwise rotating gin saw and a clock-wise rotating power roll cylinder, when viewed from the gin stand's left end (Figure 1). The aluminum seed fingers move in between the gin saws when the gin breast moves to the 'in' position. They rotate in a counter-clockwise direction. As ginned seed falls between the gin saws, the majority of seeds are exposed to the seed fingers. The interaction of the seed fingers and the seeds allows the gin saw to capture and re-introduce back into the seed roll any seeds that still have lint tails attached. The remaining seeds continue past the seed fingers into the seed conveyor auger.

The 2002 field tests showed several benefits of the PRT 141 stand versus the conventional Continental Double Eagle 141 stand. First, it was shown that the PRT stand produced a higher percentage of fibers longer than one inch. Also, an average increase in gin turnout of 31 pounds per bale resulted when operating the PRT stand. It was also shown that the PRT stand could gin up to 17 bales per hour, though fiber quality tests were not conducted on fibers ginned at this rate (Askew, et al., 2004).

Due to the success of the 2002 tests, Servico, Inc. decided to install PRT stands in all three ginning lines prior to the 2003 ginning season. The turnout and fiber quality gains realized during the 2002 test season continued into the 2003 season. However, the 2003 model stands presented a significant number of unexpected mechanical challenges. These mechanical issues were well documented by Askew (Askew, et al., 2004) following the 2003 ginning season. Askew also stated that ginning capacities (bales/day and bales/hr) were subjectively better in 2003, than in previous years. However, there was no way of verifying that statement conclusively after only one season.

The challenge going into the 2004 gin season and beyond was to identify and implement mechanical improvements to the powered roll gin stands. If this could be achieved, then the PRT units would be complete, providing excellent turnout, fiber quality, gin production rates and minimal downtime.

Mechanical Improvements

The 2002 test stand had been installed with a 30 hp variable frequency drive (VFD) (Figure 2) to allow for power roll shaft speed optimization. The optimum speed for fiber preservation, gin turnout and plant production was determined to be 180 rpm. During the 2003 season, only one of the three gin stands was equipped with a VFD since the optimization of power roll speed had been completed. The other two stands had drives sized directly for 180 r.p.m. It became evident during the 2003 and 2004 seasons, however, that the stand with the VFD continually ran more consistently. The ginners were able to run the VFD stand in "automatic" mode. However, the feeders on the other two gin stands would start slowing down the seed cotton feed rate when in "automatic" mode. Apparently, VFDs react more quickly to the power roll motor's amperage signal, allowing for better control of the feeder motor speed, than the less expensive signal transmitters. Therefore, prior to the 2005 season, VFDs were installed in all three lines.

Solid power roll shafts with replaceable flaps (Figure 3) were introduced during the 2004 and 2005 gin seasons. The 2003 model PRT stands consisted of hollow pipe power rolls with gudgeon pins and staggered bolts on the drive end. This design resulted in numerous drive shaft breakages during the 2003 season. Additionally, broken gudgeon bolts and nuts impacted and damaged saw teeth on several occasions. The solid power roll shaft eliminated the concern of excessive shaft breakages. It also eliminated the concern of steel nuts and bolts impacting the gins saws upon breakage.

Replaceable power roll flaps were introduced in the 2006 ginning season to allow for the study of various materials effects on fiber quality and production parameters. The materials tested were aluminum, steel and plastic.

The drive clutch (Figure 4) was introduced in lieu of the triple chain/sprocket combination on the 2003 model stands. During the 2005 and 2006 seasons, drive clutches were phased in to all three stands. The beauty of the drive clutch is two fold. First, it greatly simplifies the stand by eliminating sprockets and chains and the associated maintenance of these items. Secondly, it serves as the week link in the circuit between the 30 h.p. power roll motor and the seed roll. A small pin located in the clutch will shear if the gin stand overloads for any reason. Within five to seven minutes, a new pin can be inserted and the gin stand restarted.

Results

The mechanical improvements made on the PRT stands from 2004 through 2007, did nothing to alter the excellent turnout results seen during the 2002 and 2003 seasons. Through all the mechanical improvements, the cottonseed drawn from underneath the stands consistently shows minimal lint residual.

Mechanically speaking, the improvements made to the stands have greatly reduced the gin stand downtime experienced prior to installation of the PRT stands. The mechanical simplicity of the solid shaft power roll and clutch drive assembly have made the stands more mechanically stable than ever before. But the major improvement resulting from the mechanical upgrades can be seen in plant production rates over the past five seasons.

Figure 5 shows the percentage of ginning days exceeded for various bales per day production rates from 1998 through 2007. Beginning with the 2003 gin season, all bale per day production rate percentages have steadily increased up through the 2007 gin season. These production increases have occurred as the PRT stands have become more mechanically stable. Since 1998, Servico, Inc. has implemented a consistent repair program. So nothing has been changed from a repair program standpoint since 1998. From a plant machinery modification standpoint, the only major change that has occurred since 1998, is the PRT stands.

Figure 6 shows gin bales per day seasonal averages since 2002. These production numbers include all gin downtime for each season. Once again, the primary variable of change during the 2002-2007 seasons is the addition of the PRT stands.

A direct benefit of increased gin production is reduced gin labor costs per bale. Figure 7 shows the labor cost per bale trend since the 1998 season. The average labor cost per bale prior to the 2002 PRT (1998-2001) test season was $3.42/bale. The average labor cost per bale after the 2002 (2003-2007) test season was $2.66/bale. Note that the 2002 PRT test season was during a very wet harvest year, thus the labor costs per bale were elevated. Another reason for this was a high level of testing and experimentation on the PRT test stand during the 2002 season.

Power roll flap materials were evaluated to determine if one particular material would preserve fiber and seed quality better than another. Plastic, steel and aluminum flaps were installed in different gin stands during the 2006 season for evaluation. Numerous fiber and seed samples were drawn simultaneously on all three stands. Fiber samples were sent the International Textile Center (ITC) in Lubbock, Texas, for evaluation. Seed samples were sent to Delta and Pine Land (D&PL) for mechanical damage evaluation. Dr. Greg Holt, USDA-ARS, Lubbock, Texas conducted statistical analyses of the results obtained from both ITC and D&PL.

Figure 8 shows the only fiber characteristic that showed significance at the 95% confidence level. Short fiber content by weight (SFC(w)) was significantly different between plastic and aluminum, with aluminum producing fewer short fibers. There were no significant differences in visual mechanical damage (VMD) on cottonseed for the 2006 tests.

Due to circumstances, aluminum flaps were not available for follow up testing during the 2007 season. Therefore, plastic flaps were tested versus steel flaps. Figure 9 shows that there was no significant difference on cottonseed VMD between flap materials during the 2007 tests.

No fiber quality results were significantly different for power roll rpm tests at 160, 170 and 180 rpm. Figure 10 shows that the 160 rpm power roll speed produced significantly higher HiVMD than did the 170 and 180 rpm power roll speeds.

Conclusions

Gin production rates increased dramatically with the mechanical improvements made to the powered roll gin stand (PRT) from 2003 through 2007. These increased production rates occurred while maintaining excellent gin turnout and fiber and seed quality. Additionally, testing of fiber and seed quality parameters with various power roll flap materials and with varying power roll speeds showed few significant differences.

Disclaimer

Use of a trade name, propriety product or specific equipment does not constitute a guarantee or warranty by Servico, Inc. or the United States Department of Agriculture and does not imply approval of a product to the exclusion of others that may be suitable.

References

Askew, J. W., G. A. Holt, J. W. Laird. 2004. The Powered Roll Gin Stand, A Gin's Perspective. Beltwide Cotton Conferences, San Antonio, TX.

Laird, J.W., G. A. Holt, T. C. Wedegaertner, and W. F. Lalor. 2002. Powered Roll Gin Stand. Beltwide Cotton Conferences, Atlanta, Ga.

PRT Side View

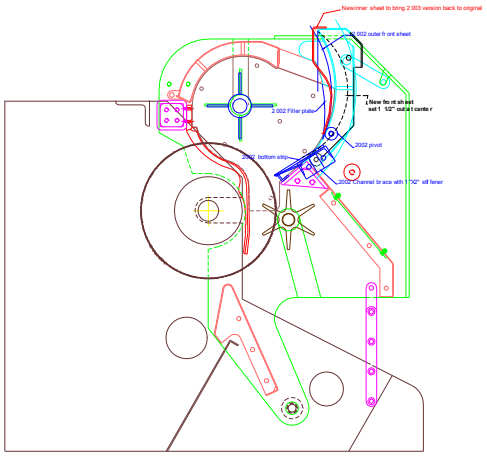

Figure 1. Left end of Power Roll gin stand.

Figure 2. Variable Frequency Drive (VFD)

Figure 3. Solid power roll shaft with replaceable flaps.

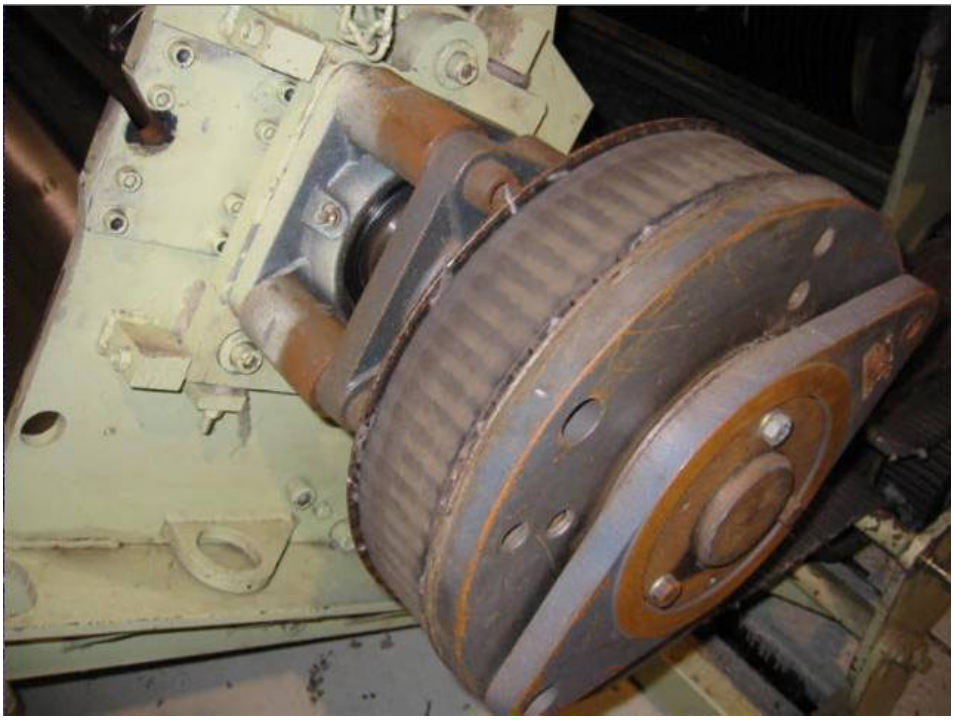

Figure 4. Power roll clutch.

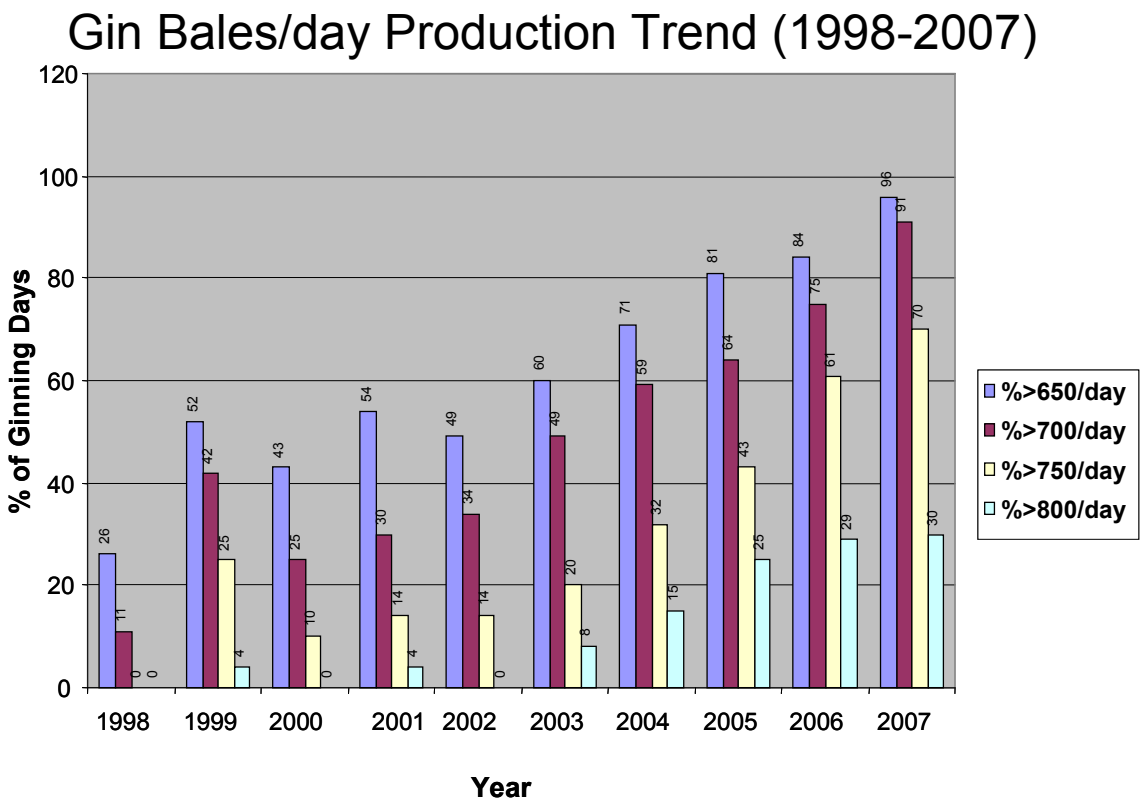

Figure 5. Gin bales/day production trend

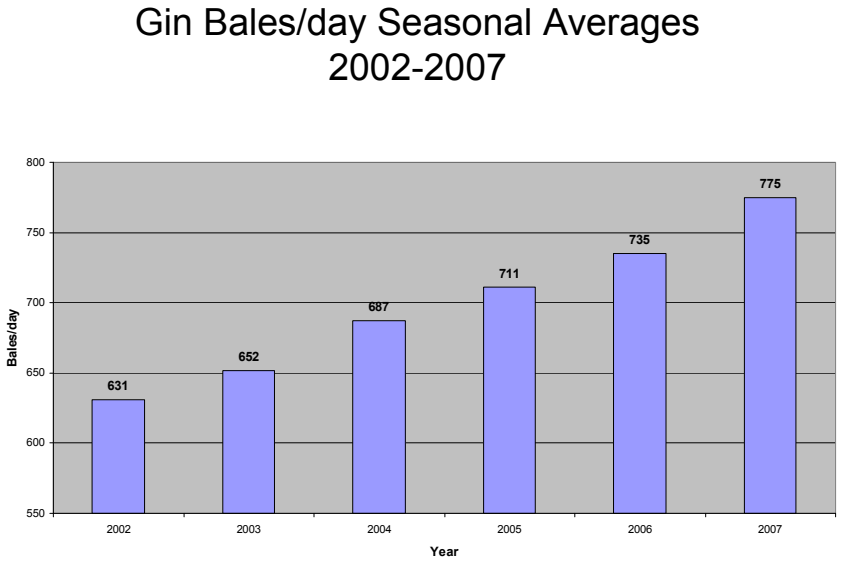

Figure 6. Gin bales/day seasonal averages.

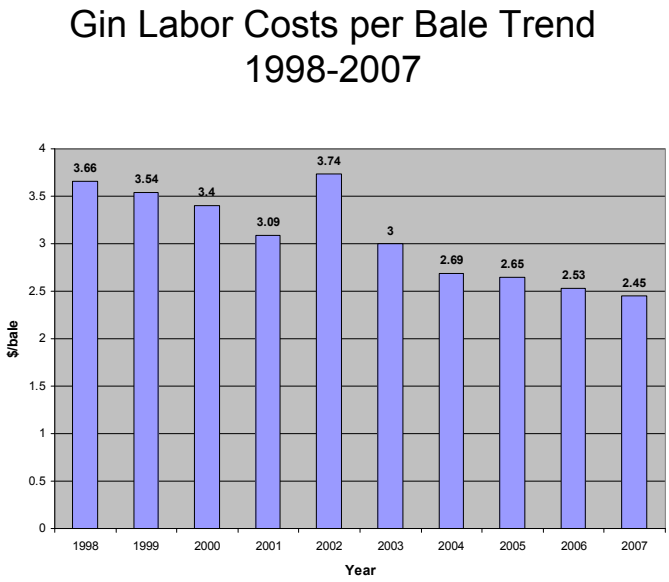

Figure 7. Gin labor costs per bale trend, 1998-2007.

2006 – SFC(w)
(flap materials)

Means with the same letter are not significantly different.

REGWQ Grouping		Mean	N	TRT
	A	8.9	5	Plastic
B	A	8.3	5	Steel
B		7.5	5	Al

Figure 8. SFC(w) was significantly different.

2007 – Total VMD (flap materials)

Means with the same letter are not significantly different.

REGWQ Grouping	Mean	N	TRT
A	11	3	Steel
A			
A	9.2	3	Plastic
A			
A	8.3	3	Steel

Figure 9. VMD showed no significant difference.

2007 – Hi VMD (rpm)

Means with the same letter are not significantly different.

REGWQ Grouping		Mean	N	TRT
A		4.17	3	160
	B	2.83	3	180
	B			
	B	2.33	3	170

Figure 10. Hi VMD higher at 160 rpm power roll speed.