MOISTURE WATCH™ MOISTURE SENSING INSTRUMENTS, RAPIDTESTER™ FIBER QUALITY TESTING SYSTEM, AND PROCESS WATCH™ MONITOR / CONTROL SYSTEM

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Abstract

Lubbock Electric Company and Schaffner Technologies, have been working together to bring timely measurements of moisture, drying, and fiber properties to the gin. Lubbock Electric Company has developed a line of non-contact moisture sensing instruments, while Schaffner Technologies, Inc. of Knoxville has developed a platform to measure cotton fiber properties. All of these data as well as other gin related information are designed to flow into a PC-based touch screen and PLC system called Process Watch™ for monitoring initially, and control ultimately. This paper will address Lubbock Electric Company's contribution to the undertaking.

Introduction

No where is the "compromise between degree of cleaning and fiber damage" (W. S. Anthony) more pronounced than in ginning West Texas cotton. Besides being virtually 100% stripper harvested, recent difficulties in proper defoliation and relatively late killing freezes cause much of the West Texas cotton crop to be harvested while still "green." Incoming moisture is often above 10% and may even reach 20% in seed cotton containing an abundance of green leaves and other non-lint trash. The common practice is to over-dry seed cotton as observation and past drying tests have shown "The greater the moisture removal…the higher the grade of the ginned lint." (Griffin and Mangialardi, 1961). The problem is that ginning and lint cleaning at low moisture levels cause excessive fiber damage; specifically shorter staple, decreased fiber strength, increased short fiber content, and increased nep counts. All of these factors create a less desirable product for spinning mills further downstream. Since fiber quality and moisture content measurements are not readily available at the gin, the solution is to use a shotgun approach of two or even three stages of high temperature drying in an effort to pre-clean trash from seed cotton before ginning.

Ginning is then commonly followed by two stages of lint cleaning in order to reduce the chance of a prep reduction and improve blending. This not only contributes to excess fiber damage, but also cotton is consistently over-cleaned (1 and 2 leaf levels) and over-dried (3-4 % in the bale). In fact, over 55% of cotton classed in Lubbock by December 22, 1999 were given leaf grades of 2's ***and better*** and remarkably 79% graded 21's and better.

In the competitive ginning environment of West Texas, "over ginning" is understandable. Presently, no system exists to determine fiber properties until samples are graded at the USDA classing office, which is too late to be of assistance to the ginner. In addition, no automatic systems exist to alert ginners when final bale moistures are excessively low. While most gins have conventional methods to add back moisture after over-drying, the effectiveness of those systems has been relatively ineffective.

Other widely acknowledged problems are:

1. Ginning and lint cleaning at moisture levels below 6% cause excessive fiber damage.
2. Over cleaning reduces the overall amount of cotton lint that a producer can sell.
3. Over cleaning (especially at the lint cleaner) can cause increased nep counts.
4. Over drying can increase short fiber content.
5. Excessively dry bales reduce the overall weight to be sold (and can result in excessive and damaging hydraulic pressure at the bale press).

Even though the ginner is not to blame for the reasons listed above, the net effect is that the producer consistently receives lower revenue while the mill receives lower quality.

Discussion

The industry is in need of the ability to automatically measure conditioning (both moisture and the effects of drying) in conjunction with obtaining timely feedback as to the quality of the final product. Ultimately, these data can then be processed and converted into automatic control of the entire ginning process.

Unknown to each other Lubbock Electric Company and Schaffner Technologies were independently working on separate pieces of this total puzzle.

In 1994, Lubbock Electric Company built a PLC console for the Hoke Robeson Gin in Red Springs, NC. Separate from the main console was a separate PLC connected to an industrial PC with a graphical representation of the plant. The inputs consisted of moisture instruments, thermocouples, shaft monitors, motor overloads, and variable speed references. While the concept was sound, the missing components were accurate and precise moisture instruments. Consequently, the

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system was never of much value to the ginner. Lubbock Electric Company has subsequently built 30 complete PLC consoles that have incorporated graphical speed references, shaft monitoring, motor load monitoring, and temperature controls.

In 1997, Schaffner Technologies was working on rapid conditioning and nep testing. In January of 1998 Schaffner Technologies and Lubbock Electric Company agreed to cooperate on the development of a complete system for a cotton gin that would provide the entire gamut of cotton fiber measurements as well as a complete analysis of the moisture / drying / conditioning aspects of the process.

Moisture Watch™

In response, Lubbock Electric began working on a non-contact moisture sensing system to acquire final moisture content of a packaged bale of cotton. After experimentation, the determination of moisture content by the use of low frequency radio waves proved superior to any other method evaluated in the lab.

The unit was packaged into enclosures, named Moisture Watch™, and mounted on the framework of the bale conveying system at Buster's Gin in Ropesville, Texas (Mr. Dan Taylor, owner). The transmitter was mounted on one side and the receiver was mounted on the other side so that the bale would be conveyed between the two. A digital meter mounted through the outside of the enclosure provided a local display, while a 4-20 ma signal provided a control signal to a remote PLC system. As expected, the original product needed much improvement including power regulation, noise elimination, signal conditioning, and frequency filtering. By December of '98, the unit was calibrated and tested using conventional oven drying techniques. The unit was then tested at three other sites, with similarly encouraging results.

Eleven final moisture units were installed for the '99 season and have performed virtually trouble free. In addition, an intermediate and two incoming moisture units were developed using the same electronics. The intermediate unit was tested at four sites, the stationary head feeder unit was tested at two sites, and the traveling head feeder belt unit was tested at one site. (The belt unit for traveling head feeders does not have the capability to correct for the wide variation of seed cotton densities on the belt and has been abandoned.)

The stationary head incoming unit was modified late in the season and showed promising results, although further testing and sampling are indicated. Likewise, the intermediate unit seemed to indicate varying moisture levels but time did not permit exhaustive testing.

All of the existing units will be brought back in for some additional electronics to enhance speed, averaging, signal filtering, and the analog output which will ultimately be used for burner and humidifier control.

Envisioned applications of the Moisture Watch™ instruments are varied and readily applicable. First, the instrument can detect incoming moisture while seed cotton is in the module *before* entering the feeder head. Accurate moisture information can therefore be supplied to the drying system controls in time for them to react to changing moisture conditions in an exact and controlled manner. That is, burner control systems are no longer forced to react almost instantly and violently to changes in moisture.

Second, the instrument is being evaluated for installation just before the gin stand. Thus, gins can integrate their entire cleaning and drying systems to not only prevent fiber damage but maximize gin stand efficiency. The ideal seed cotton moisture range for ginning is 6-8%. Research suggests that at 7%, the ratio of fiber tensile strength to force needed to separate fiber from its seed is at an optimum level, though this varies by variety (Moore and Griffin).

Third, the original Moisture Watch™ was designed to determine final bale moisture. This is extremely important in two areas:

Monitor and Control

Final bale moisture can be utilized to monitor and control specific moisture control systems within the gin such as humidifying and drying. The instrument can also help a ginner to understand the gin's entire system and its reaction to changing atmospheric conditions. Additionally, final bale moisture is extremely important to press operations.

Merchandising of Cotton

It is the ginner's duty to provide his customer with the greatest economical advantage possible. Presently, the large majority of cotton is sold by the producer basis certified gin weights. Moisture Watch™ final bale moisture is installed at or near the bale scale. Now gins can accurately know the final moisture of the cotton that it is producing and can react accordingly. The difference in weight, on a wet matter basis, of a bale at 4.5% moisture and 7% moisture is 12.5 pounds of cotton (or from 26% turnout to 26.7%). The accurate determination of moisture at the point of weighing is extremely important in giving customers the most value possible.

Process Watch™

To facilitate monitoring (and ultimately control) of the moisture/drying information and the fiber quality measurement information, a separate system was needed. The result is Process Watch™, which consists of a PLC control

coupled with a touch screen PC graphical interface. Process Watch™ is connected to all moisture instruments, thermocouples, shaft monitors, motor current transformers, and the RapidTester™. All parameters can be configured to produce alarms, which can alert the ginner to possible problems with the ginning process. All of the information for each bale is recorded and stored in an MS Access® database format.

The Process Watch™ system was installed in three West Texas gins for the 1999 gin season. Ultimately, this platform can be used for direct control of dryers, humidifiers, and the amount of pre-cleaning and lint cleaning used in the gin. At present more evaluation is indicated for Process Watch™ and commercial applications for the 2000 season will be limited to a few West Texas gins.

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