FOUNTAIN DRYING SYSTEMS

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Abstract

Drying system performance is based on three essential factors, air/cotton ratio, drying air temperature and drying device effectiveness. These are combined in several ways to design our company's high-performance drying systems.

Introduction

The reason for holding this panel discussion is that most new gins built in the past few years have installed drying systems other than the two tower stages formerly considered standard. Eight years ago, I presented a Beltwide paper entitled "Design Precepts for Towerless Drying Systems", which caused a lot of controversy. The devices and design ideas which I presented then don't seem so radical now, and they're being widely applied. The atmosphere has changed, and I welcome the new members to the club. There is room for all of us. Any unfavorable comparisons which I make in my talk are directed at old-style tower drying systems. The systems described by my fellow panel members are all good improvements and include several of the methods I will describe.

I will explain the logic of our company's approach to cotton drying and describe some of the results we obtain.

Three Major Drying Factors

There are three major factors in the cotton drying problem, and they work in much the same way as a three-legged stool. Each leg is necessary, and bad design of any leg can make the stool useless. Let's consider the first major factor.

1. Air/Cotton Ratio

This is one of the most important legs of the stool, and it is difficult to attain. We define air/cotton ratio as the number of standard cubic feet of hot air applied to each pound of incoming seed cotton before it enters the first precleaner.

Note that we consider only the hot air applied <u>before</u> precleaning. We do this because our experience has shown that attempting to preclean seed cotton while it is wet entangles the trash in the fiber. This actually lowers its grade and increases lint cleaner waste. The number of bales ginned to produce a bale of uncleaned motes gives a good idea of this effect. Old tower systems typically will run around 25 bales of cotton per bale of motes, while new high-air-volume systems can be as high as 80 bales/bale of motes.

In two-stage precleaning systems, handling the recommended two bales per hour per foot of cleaner width, we have no trouble in achieving a ratio of 50 cu ft of hot air per pound of seed cotton. Most other systems use 20 cu ft/lb or less. By using more complex techniques, we have achieved a ratio of 57 cu ft/lb even while loading the precleaning system with three bales/hr per foot of width. This was difficult to do, and the system was complex. On this point of cleaner loading, we strongly recommend staying with the figure of two bales per hour per foot of width. You will have generous precleaning capacity, and you can use a simple Fountain system to dry your cotton.

The best way to get a high air/cotton ratio is to use the skimmer, which we originated and first described in our paper of eight years ago. It takes a stream of air and cotton at the end of the drying process and diverts the cotton and about half the air to the first-stage inclines. The remainder of the air is used to pick up the cotton under the stick machines to go to the second-stage cleaners. In this way, we use all the air for drying before the first cleaners.

Another technique we use is to take some extra air from the skimmer and reheat it for use in the drying system. Such recirculation has enabled a plant with single stream 10-foot wide precleaning to cruise at 35 bales per hour, slowing down only slightly for wet seed cotton. This gin, Jones County Cotton Gin at Trenton, NC, ginned 60,000 bales last year, and 50,000 this year. They had a bad crop this year. The manager, Billy Cox, says to tell you their new drying system increased their cotton-to-motes ratio from 25 to 65 bales/bale of motes.

2. Hot Air Temperature

By this, I mean the temperature of the drying air before the mix point. In the old tower dryer systems, which used low air volume, getting the air hot enough was not a problem. In fact, the air temperatures were usually too high. Now that almost everyone is experimenting with high-volume, pull-through systems, they often find that their old heaters are too small.

While the drying air must be heated, this should not be overdone. The USDA Cotton Ginners Handbook recommends that drying air be no hotter than 350 deg F. Everyone should have a modulating high limit controller to display this temperature and keep it below a harmful level. Most gins do not. All Samuel Jackson heaters sold in the past six years measure, display and control the drying air temperature.

3. Drying Device Effectiveness

This is the third leg of our stool. Even though we have provided enough hot air of the proper temperature, we still must apply it to the cotton in effective ways to have a high-performance drying system. Let's look at some of the drying devices we use.

In a simple tower drying system, most of the drying is done at two places. The first is at the air-cotton mixpoint and within 10 feet after it. This is because the hot air is accelerating the cotton up to the air velocity, and removes moisture from the cotton as it moves through it. The second place is in the inclined cleaner where the hot air is separated from the cotton, and again moves through it.

Almost no drying is done in the pipes or in the tower because the hot air moves along with the cotton instead of through it. We can cause this flow-through by accelerating the cotton with hot air or by physically holding the cotton while the hot air passes through it.

We have devised a number of such processes and enhancements. The first was the Fountain dryer, which floats the cotton lazily in the hot air then re-accelerates it. Ironically, its drying effect takes place, not in the dryer, but at its exit. Another asset of the Fountain is its ability to pass a large volume of air with negligible pressure drop. This is perfect for pull-through drying systems with high air/cotton ratios.

The principal reason for the declining use of the tower is its restriction of air flow. Ten years ago, a new gin with split precleaning would have four towers totalling 92 shelves. This year, some new gins were built with only one tower having six deep shelves. Others simply did without towers, as we did in our first towerless system in 1986.

One of our enhancements is to inject extra hot air at the exit of the Fountain to increase the drying effect at that point. The hot air hits the cotton with a velocity of 6,000 ft/min and most of it travels with the cotton to the first-stage inclines, increasing the drying effect there.

We use the Hot Box to pick up the incoming seed cotton from a belt conveyor with hot air. It can handle 60 bales/hr from a 36" wide belt trough. It replaces the blow box and has several advantages in plant layout, junk removal, choke-free operation and low maintenance.

Our Collider-Trap directs the stream of incoming seed cotton against an opposing stream of hot air, which has a carefully controlled velocity. The locks of cotton are slowed down and turned around by the hot air stream. This dries the cotton while dropping out gravel, weed seeds, unopened bolls and rotten cotton. Keeping rotten cotton out of the gin stand seed rolls eliminates problems there and increases ginning capacity on wet cotton.

The Air Flow Regulator passes a constant volume of air despite changes in static pressure. When we are injecting hot air later in the system, this prevents hot air from bypassing the initial mix point and causing a choke. We always use this regulator with the collider-trap to maintain a constant air velocity in the opposing hot air stream.

Proper Combination of the Three Drying Factors

Just as all three legs of the stool are necessary, so are all three of the major drying factors. Neglect of even one factor will prevent the drying system from being a success. The proper balance of all three depends on the experience and skill of the drying system designer. We have a team of engineers which is the best in the world. They have designed and sold more than 75 Fountain drying systems, now used on five continents.

To insure that the three main factors of the drying system will work together properly, the following factors are also essential:

Complete Engineering of the entire cotton flow system. This includes air volumes, pipe sizes, fan types, speeds and horsepower, cyclone sizes and the design of special transitions.
Start-up Supervision assures that the system has been constructed as designed, and the air volumes and velocities are adequate to dry and convey the cotton.

Automatic Controls needed include cascaded temperature controls using both after-mix and before-mix temperatures. We also measure the cotton moisture content and use it for control purposes.

The "Sled" is a control device which we install over a belt conveyor to measure moisture content of incoming seed cotton. It regulates the amount of heat from all the burners in the gin. by changing the set points of the temperature controllers. It speeds dryer response and usually cuts the fuel cost in half. It can also provide a signal to divert wet cottonseed to an alternate storage for special handling. If the plant is properly arranged, it will measure both moduled and trailer cotton.

Economic Considerations

Our drying systems usually have a per-bale fuel cost which is less than other systems. In wet regions, where we greatly increase the bales ginned per week, the per-bale costs of fuel, electric power and labor are all considerably lower than those of conventional tower systems.

Where farmers own the cotton gin, an important plus is the increase in lint turnout, as explained above. The value of this factor can be more important than the reduction in ginning costs.

The ability to gin wet modules promptly means a lot in wet years. The difference in value of cotton from wet modules ginned within about ten days compared to the reduced value caused by deterioration in the module can be more than $200 per bale. This loss to the farmers makes the cost of a high-performance drying system look like small change, indeed.

Drying Performance Comparisons

To help the ginner who has a conventional tower system compare what he is now doing with what he should expect to do with a high-performance drying system, we offer the following figures:

Hot Air Temperature. Every drying system should limit the air temperature ahead of the mix point to less than 350 deg F, and should use this temperature only on the wettest cotton. On average cotton, one would therefore expect to use 250 deg or less. In checking these temperatures, be sure to measure them before the mix point. Do not measure pipe surface temperatures, such as are made with an infrared meter, but drill a small hole in the pipe and insert a thermocouple probe into the hot air stream. The air inside is always hotter than the outside of the pipe.

Lint Cleaner Waste. Expected lint turnout is indicated by the number of bales of cotton which are ginned to produce one bale (600-pound equivalent) of uncleaned motes. If the motes are cleaned in the gin before baling, this item will not mean much. This figure is a good indicator of how well the seed cotton is dried for most efficient precleaning. It should be above 60 bales of cotton per bale of motes for a good drying system.

Fuel Cost. Based on preliminary 1995 figures in Georgia, fuel cost should be about one dollar per bale.

Electric Power Cost. On the same basis, electric power should cost from $2.00 to $5.00 per bale.

DRYING SYSTEM