Ethanol PRODUCER MAGAZINE
The World of Ethanol at Your Fingertips

From the November 2007 Issue

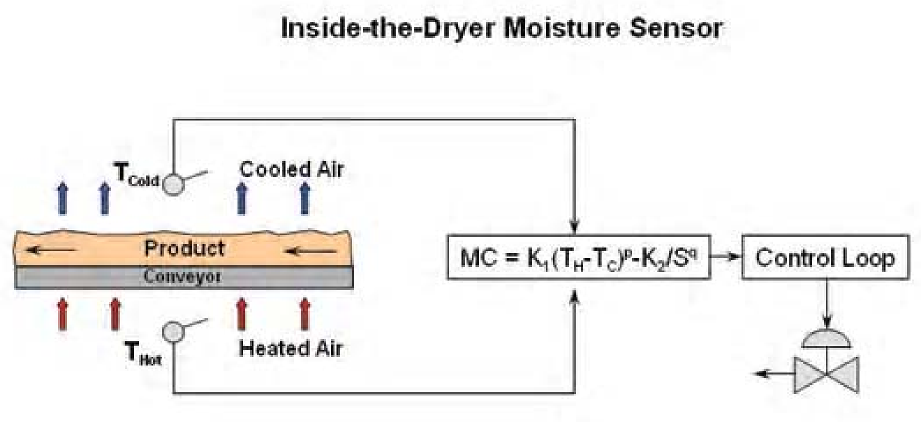
Higher Profits with Tighter Moisture Controls

EPM talks with Drying Technology Inc. about its Delta T Moisture Control System to save ethanol producers cash by gaining tighter moisture control in their distillers grains dryers.

by Ron Kotrba

As a chemical engineering graduate from the University of Oklahoma, John Robinson worked in several different forestry, paper and chemical companies in his long career: International Paper Co. and Dow Chemical Co. to name a few majors. Decades spent working with forest products, timber and plywood provided Robinson with a vast amount of knowledge and experience, which he ironically used to develop a simple moisture control system from first principles. These first principles are irreducible, elemental and fundamental to a field, whether its engineering, physics or chemistry—and sometimes can be overlooked. In the late 1970s, using the age-old engineering term Delta T, where T stands for temperature and Delta connotes a difference, Robinson derived a control model that relates moisture to temperature drop. "It's so simple that when we tell people about it, many say, 'You can't do that,'" Robinson says.

The idea was patented in the mid-80s and a couple of years later Robinson formed his own company, Drying Technology Inc., based on these first principles and Robinson's application of them. "The system was first applied in making plywood, which uses a veneer—the thin wood that goes into plywood," he tells EPM. Once Robinson realized that his system worked on the conveyer dryer, he applied the model to other dryers and found out that it was universally applicable. Five dryers work particularly well with what Robinson calls the Delta T Moisture Control System: conveyer, spray, flash, fluidized bed and, most common in the ethanol industry for distillers grains drying, rotary and ring. "I applied it in the plywood industry and we actually became the industry standard," he says, thanks in large part to Georgia-Pacific, which bought 30 of his systems in one shot. "That kind of gave us a good start." A good start was all Robinson needed.



Delta T Moisture Control System

After saturating the plywood industry with his company's moisture controls, he proceeded to apply them to batch systems for drying lumber and then in the carpet and textile industries. "Then we got into the food industry servicing big-name companies like Kraft—Maxwell House instant coffee, which uses spray dryers," Robinson says. "Then, after that, we turned to the panel board industry for applications drying fiber for medium density fiberboard, which is used in furniture and uses flash dryers for drying the pulp. And then we got into pet food." It appears it was only a matter of time before Robinson set his sights on the ethanol industry. In fact, he's already servicing big names in an industry that's closely related to the ethanol industry: corn wet milling. About 1½ years ago, Robinson sold his dryer control system to a company called Roquette, for use in a ring dryer for gluten. The French-owned company now has plans to incorporate four more of Robinson's moisture control systems. Another well-known wet-miller in the ethanol industry has recently purchased a Delta T to utilize the simple, highly effective moisture control method to gain tighter control, increase profits, reduce energy consumption and produce a more consistently dried product. Robinson requested that the name of the company remain confidential until the deal is finalized.

The System
Robinson's Delta T system measures moisture with two temperature sensors and a mathematical model. Because it's based on

fundamental principals it's universally applicable. "I put some stuff together—a couple of differential equations—and solved them, and the mathematical analysis produced this simple model that relates moisture to the Delta T, the temperature drop, minus a term for production rate," Robinson says. "It has constants and exponents in it, and what I immediately saw was a convenient, variable temperature drop that could be easily obtained using ordinary temperature sensors. Most importantly, it enabled a moisture sensor for the first time to be installed inside the harsh environment of a dryer." Surely if he could do it others could too—right? Not according to Robinson.

Even though the patents have expired and now reside in the public domain, there's proprietary information at play in the Delta T system. "There are a lot of theoretical things that have to be helped along," he says. "We've got more than 20 years experience with it. Most people are building moisture sensors and must install them on the end of the dryer—that's too far away."

He details at least three major deficiencies with current moisture control systems utilized in the U.S. ethanol industry: The use of exhaust temperature as a substitute for the moisture content of the exiting product; the lack of moisture sensors inside the dryer to effectively reduce dead time (the time required to detect a "disturbance" with inbound feed) and the lack of a general moisture control model based on first principles.

A majority of distillers dried grains dryers use plain exhaust temperature. There is an evident correlation between exhaust temperature and moisture if there are no disturbances—changes in the water rate or the evaporative load—but "we live in the real world and that never happens," Robinson says. "There are always changes in either the percent moisture of the feed coming in or maybe changes in production rate. The overall water load that has to be evaporated varies and that distorts the correlation." Once the correlation is distorted, another set point is needed to maintain target moisture.

If a disturbance occurs and the product comes out of the dryer wet, the controller's logical reaction is that it's still coming into the dryer wet. "The controller has to assume that it's still coming in wet until the sensor indicates otherwise," Robinson says. "The controller has one decision out of three—it's either coming in wet, it's returned to the steady state (or normal), or it's coming in dry. Well, the controller picks one—still wet. 'Okay, it's wet so I'm going to add heat.' Control systems using a sensor outside the dryer have only a 33 percent chance of making the right decision." This exhaust temperature approach is simple yet inherently flawed, Robinson says, because there are no reliable methods for automatically and continuously adjusting for disturbances entering with the distillers grains. On the other hand, there are highly sophisticated systems with good control, but they require a great deal of training. "With those, operators have to come in and train for two to three months and it costs a lot of money," Robinson says. "They can be effective but the sophistication is so great. You can't keep master's-degree engineers doing the controls—regular people around the plant need to be able to understand it. And, you still need a reliable and rugged moisture sensor for this type of control."

Because conventional sensors cannot be put inside the dryer, most just go for the exhaust method or a conventional sensor downstream, but the dead time it takes for a disturbance to be detected is so high that Robinson says this method is not effective. "Some attempt to measure the total amount of water coming into the dryer so you must have a moisture sensor on the feed, and also you've got to have a mass meter to measure the total pounds," he explains. "If you've got the percent moisture, you can measure that and say, 'Well I've got so many pounds of water entering the dryer so, when that changes, I will feed forward the change to my feedback control mechanism and that will compensate for what's coming in.' That sounds good on paper and in some sophisticated refineries it might be useful, but then you've got to have another moisture sensor that must be put on the high moisture content material, and we've found those that work well are hard to come by—they need an expensive mass meter, which is a weigh belt and that's got to be maintained. If those are suspect, all it can do is give a trend, not an exact measurement. Our Delta T system measures the temperature drop of the air going through the dryer—it's a measure of how much water is actually in the dryer at that time—and a measure of the drying rate and moisture exiting the dryer so it'll immediately detect a disturbance."

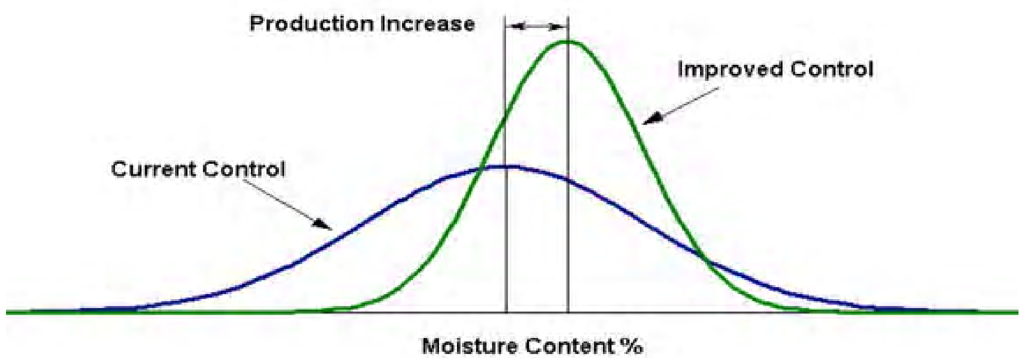


Figure 1. The data for this graph was accrued from clients using the Delta T System.

Data suggests the Delta T Moisture Control System by Drying Technology, can reduce moisture variation between 30 percent to 45 percent (see Figure 1). "We can always improve somebody else's control system by a minimum of 30 percent," Robinson says. "If you can raise your average moisture content a half a percent or more and sell more water but still remain within the spec, that's money. Most [dryers] can't control moisture as well and end up over drying so the spikes in moisture content are below their upper specification limit."

When people see that the Delta T moisture sensor consists of just two temperature sensors inside the dryer, they don't consider it to be a moisture sensor. Robinson's response is a question: What is a moisture sensor? Their reply is usually, "Oh, it's a mechanical box that's got electronics and stuff in it." Robinson explains to them that his moisture sensor is based on a physical principal that has a mathematical correlation. "That's all I'm doing. I've got a mathematical model that demonstrates a very high correlation between moisture and temp drop."

Ostensibly, selling his design to major dryer makers would be a good move, but the business is so competitive. "They really just want to sell dryers," he says. "They'll put standard controls on it—like the exhaust temperature—and I've found they're really not interested in adding a cost that perhaps their competitor is not adding. If they add my system then they've got to add my price." The price is small compared with its return on investment, Robinson says, explaining that it should not run more than $40,000. Robinson says the investment—at a 30 percent to 45 percent increase in moisture control (upping moisture content by three-quarters of 1 percent) and if distillers grains prices were $100 a ton—can generate an extra $111,000 per 100,000 tons of distillers grains, or more than $360,000 for a typical 100 MMgy plant. The $40,000 basically purchases the software and about five days worth of start-up and training. "Start up is simple," he says. "It's like cruise control. Just start-up on manual and when you get your target moisture where you want it go to auto control. It's already trained and calibrated. It'll hold there despite disturbances." Occasionally an operator will grab a sample to verify moisture content, which is routine.

Ultimately, the effectiveness of his moisture control system led Robinson to coin the phrase, "It renders feedback obsolete and feed forward unnecessary."

Ron Kotrba is an Ethanol Producer Magazine *senior staff writer. Reach him at rkotrba@bbibiofuels.com or (701) 746-8385.*