CONTRIBUTION

New Algorithm Aids DDGS Moisture Control, Profitability

A case study demonstrates improved dryer performance

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Ethanol producers are caught in a dilemma with regard to moisture content (MC) of DDGS during drying. This is caused by lack of reliable and cost-effective MC sensing and control. Most ethanol producers avoid operating too close to the upper specification limit and choose to over-dry rather than produce wet product that could lead to catastrophic losses from mold growth or trouble unloading railcar shipments. The costs for using the safer MC option include at least one-half percent less production, higher unit thermal energy consumption and possible degradation of product quality by higher temperature drying. An alternative option improves moisture control by reducing the standard deviation significantly to move the target MC closer to the upper specification limit.

A recently installed system at one of Green Plains Renewable Energy Inc.'s 100 MMgy ethanol plants provides a case study of what is achievable using the DeltaT MC sensing and control system developed by

Drying Technology Inc. The improved moisture sensing and control system had shown its potential by significantly improving moisture control in other process industries, including a related process, corn gluten production. Green Plains recognized the potential to improve their control and agreed to conduct a trial.

The plant includes two typical rotary dryers. Evaporative load disturbances are typically caused by low syrup levels and normal production rate changes, as well as the deliberate bypass of some distillers grains for sale at higher moisture content. The originally installed moisture control system used exhaust temperature as the process variable for inferring moisture levels or a manual system that used downstream lab MC data as the basis for changing burner valve positions. The dead time (time lapse before detection of a disturbance entering with the feed) for control responses using "after-the-fact" MC data was too long, resulting in wide moisture variation. In addition to dead time problems, there was no control algorithm for precisely adjusting the setpoint to obtain the target moisture level. Such operation parameters are costly and demonstrate the necessity for improving current MC sensing and control capability. The exhaust temperature control system was replaced by the Delta T. A downstream, inline, infrared MC sensor was available, but not used for control purposes; it continuously displays MC trends.

DTI's exclusive technology is based on a first principles derived math model that supplied a control algorithm and an inside-the-dryer moisture sensor resulting in a control system that can significantly tighten moisture control. The model, $MC = K_1(\Delta T)^p - K_2/S^q$, relates: 1) the product MC exiting a dryer to the temperature drop (ΔT) of hot air after contact with a wet product and, 2) the production rate (S). This patented new method senses the moisture of a product while it is being dried, thus significantly reducing dead time. Additionally, it provides the theoretical basis for a control algorithm that enables precise adjustment of the setpoint value of ΔT to produce the target MC following evaporative disturbances to the dryer.

Improvements in dryer performance promise solid returns. Drying Technology guaranteed a minimum 30 percent reduction in product standard deviation exiting the final dryer of each line. Using its operations as an example, the Green Plains plant produces approximately 318,000 tons of distillers grains per year. Assuming the plant sells 10 percent as wet feed, the potential savings from the remaining 90 percent of production would be $286,000 per year minimum. Total DDGS produced from Green Plain's eight other plants with ethanol production of 640 MMgy is approximately 2.034 million tons per year. Assuming 90 percent is dried to the lower MC specification, the total corporate annual savings are estimated to be approximately $1.83 million.

Plant Evaluation

A pre-engineering visit was conducted by Roger Douglas, DTI director of engineering, to discuss installing a Delta T on each of the two rotary dryers in line A-B for testing. The Delta T software was load-

Figure 1 **Moisture Data Before and After Delta T**
Line A-B

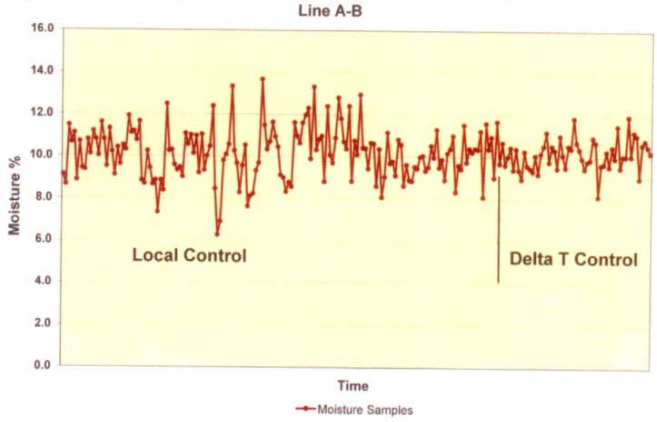
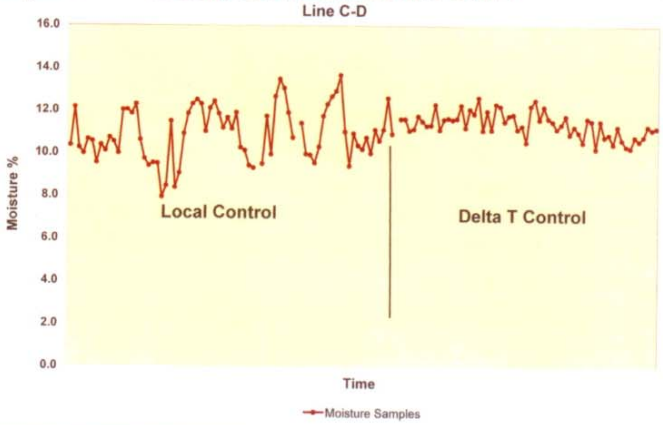


Figure 2 **Moisture Data Before and After Delta T**
Line C-D



SOURCE: DTI

ed onto a desktop computer for performing calculations and connected to the distributive control system (DCS). The DCS supplied the necessary inline sensor data needed for the calculations. The output signal to the burner was switched from the current system to Delta T control by a button on the DCS screen. No additional sensors signals were used. Each dryer in the line is independently controlled by Delta T, with the goal of reducing the MC variation from each dryer by 30 percent, which theoretically reduces the overall standard deviation by 49 percent.

Figure 1 shows several days of MC

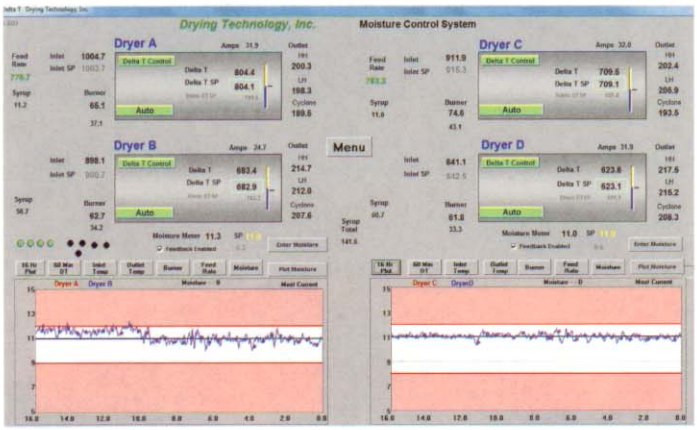


Figure 3 Data from both dryer lines shows 16-hour plots of moisture content data.

data recorded prior to installation followed by startup data for the first week of Delta T operation that showed a 41 percent reduction in standard deviation. Since then, the Delta T has consistently operated above guarantee levels on the first line where it was installed, and has been well-received by all four operators. A benefit operators remain excited about is the ability to take a centrifuge down and bring it back online without having to worry about the dryers or the moisture of the product.

Based on the results from the 30-day observation, a Delta T control system for the second line was installed in October and placed in auto mode on startup. Figure 2 shows before and after MC data from the second line where the reduction in standard deviation was 54 percent during the startup week.

The Delta T computer control screen in Figure 3 presents data from both lines more than six weeks after installation showing 16-hour plots of MC data from the two inline IR moisture meters. Dryer line A-B was initially set on a target MC of 11.5 percent, but later shifted to 11 percent to adjust for the cooling drum MC. The C-D line was operated at a target MC of 11 percent during the entire 16-hour period.

The two main problems causing ineffective MC control at Green Plains are common within the process industries. The commonly used, nonproprietary exhaust temperature control method is ineffective due to the lack of accurate, reliable "inside-the-dryer" moisture sensing upon which to base control decisions and lack of a control algorithm that enables precise calculation of setpoints following evaporative load disturbances entering with the feed. The resulting dead time forces ethanol producers to operate at a lower mean MC, thus costing them at least $1 per ton of DDGS. The plant trial documented the additional revenue and energy savings that was theorized prior to purchase and showed a return on investment of less than a year. The operations staff at the initial installation has come to rely on the new software. After a recent planned shutdown, the software was put in automatic control even while ramping up plant rates. Plans are underway to implement this technology at other Green Plains plants.

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