Automated Measurement Key To Bio- Ethanol Refinery Efficiency

By Hemant Narayan
The conversion of corn into fuel ethanol is again gaining popularity and becoming an appealing business opportunity for farm communities and agri-businesses. Investors are attracted by the prospect of more than doubling the monetary value of a bushel of corn by converting it into 2.75 gallons of fuel ethanol, 17 pounds of animal feed and other value-added byproducts. In the U.S., more than 120 plants are now producing ethanol from corn feedstock, and another 76 are under construction. Dozens more are in various stages of planning with total domestic production capacity expected to double during the next five years.

The rapid increase in production reflects the expanding market for bio-ethanol. If an E10 (10 percent) blend were to replace all 140 billion gallons of gasoline consumed in the U.S. annually, 14 billion gallons of ethanol would be required. Add to this a push from state legislatures for the market adoption of E85 (85 percent) blends, and it is easy to understand the high level of new production capacity.

Thin Profit Margins

The strong demand, however, represents only a part of the profitability equation. The whole proposition is not profitable if inefficiencies in the production process add significant costs due to excess energy consumption, poor yields or waste. Unfortunately, in many cases, that is what’s happening. The cost of natural gas and other utilities are especially problematic, as these items far exceed other major cost components. For example, in a typical plant, the natural gas that fuels boilers, evaporators, dryers and other equipment comprises 15 percent of the cost of producing a gallon of ethanol. For a 100-million-gallons-per-year plant, that translates into millions of dollars in costs.

Moreover, when an ethanol production facility comes online, increased local demand for corn puts upward pressure on prices and poses problems with feedstock variability. Some producers report that ethanol yields vary as much as 7 percent depending on corn variety.

Achieving consistent profitability can be a challenge. An individual ethanol producer has little influence on the market price it receives for the product it ships, and little control over the price of feedstock and natural gas. Ethanol producers must tightly control their manufacturing process, and thereby produce consistently high yield, while minimizing the consumption of energy and raw materials.

Importance Of Measurement Device Selection & Placement ?

Careful selection and installation of measurement devices are important for three reasons:

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Measurement devices serve several purposes in ethanol plants:
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At various points in the production process, it is also necessary to measure and control temperature—during cooking, fermentation and distillation, for example—as well as other attributes, such as pressure, pH, conductivity and moisture.

Every stage of production demands precision, and a measuring device supplier must understand the entire ethanol production process, as well as the best available technology and suitability for each type of measurement. Performance is not just a question of selecting the best device for the application. Proper placement of the device in the pipeline or tank is also critical, not only to ensure accurate measurement, but also to avoid distortions, clogging and damage. Achieving performance and controlling total lifecycle costs also depend on preventive maintenance and periodic calibration checks on some instruments.

This article provides examples of how accurate measurement improves efficiencies and contributes to profitability in typical dry-milling processes.

Getting More Out Of Solids Measurement

Many production operators understand the importance of percent solids control for effective fermentation and ensure measurements are routinely conducted at various points in the process. Unfortunately, most percent solids measurements are only periodically performed by a laboratory moisture analyzer. Although the analyzer may be calibrated for high accuracies, this testing process usually proves unreliable in practice.

As a result, an increasing number of plant operators are opting for real-time online measurement to continuously monitor the contents of the mixing tank and make instantaneous changes to the process. Plants are thereby able to maintain acceptable tolerances (typically within 0.5 percent). This control allows more consistency in slurry mix solids and enables operators to push solids ?percentages higher. By continually measuring percent solids, a record ?is established for each fermentation batch. The data facilitates realistic prediction of the outcome of the fermentation process in order to ?optimize the overall process by reducing problems with previously encountered flow issues.

Industrial-grade Coriolis meters have proven to provide accurate and repeatable density measurements as the basis of good solids measurement. The bent design and internal flow splitters in some Coriolis meters frequently fail due to fouling and blockages; these problems, however, have been eliminated by single straight-tube Coriolis meters.

Optimizing Ethanol Rectification & Dehydration

Rectification and dehydration provide a textbook case of the importance of accurate measurement for ethanol process control. The goal of rectification is to achieve maximum purification (up to 190 proof); then dehydration employs molecular sieves

to convert the 190-proof ethanol into 200, going from 5 percent moisture content to 0. If the process fluid moves too quickly through the molecular sieves and moisture remains, then the batch must be run through the dehydration system again—wasting energy and tying up production. To avoid this, a plant could extend dwell time in the molecular sieves to ensure that all moisture is removed. However, this margin of comfort comes at a cost in terms of productivity and energy.

Alcohol proof measurement of rectifier and dehydration output can dramatically improve process efficiency. Precise density measurements can detect exactly when the ethanol reaches the anhydrous threshold (zero moisture content), so that the dehydration process can meet its target without overreaching, obviating the need for a comfort margin.

Single straight-tube Coriolis meters have proven to accurately monitor alcohol proof in real-time during the rectification and dehydration processes. Continuous trends data allows for instantaneous process upset correction and consistently tight control of proof values in final product. Another advantage of Coriolis meters is their ability to measure multiple parameters in a single device—proof, density, temperature and flow.

Volumetric & Steam Consumption Control Flowmetering

Dry-milling ethanol plants also make use of inline electromagnetic flowmeters to measure flows containing high solids content. Most magnetic flowmeters use pulsed DC technology, which involves performance limitations, especially in noisy applications. These problems can be addressed by using signal converters with digital noise filtering and a low-noise electrode configuration. Advanced magnetic flowmeters provide self-diagnosis to detect sensor coating degradation, and predict electrode or liner failure.

The multiple-parameter capability of some flowmeters provides an added benefit during clean-in-place (CIP) procedures. CIP washes include flushing the lines and recirculating chemical in a specific sequence, such as acid-water-alkali-water. By using the conductivity measurement feature built into the flowmeter, the process can be controlled automatically and remotely to ensure a more efficient CIP cycle, supporting chemical reuse.

Flowmeters also play a role in controlling energy consumption by measuring the flow of steam used in cooking, dehydration and evaporation. Steam measurements are performed on a mass flow basis, even though the high moisture content in saturated steam vapors causes failure of true mass flow sensing designs, such as Coriolis and thermal mass meters.

Consequently, volumetric devices like orifice plates or vortex meters are available, but most of these devices measure the velocity of steam in the pipeline and compute volumetric flow rate from the line size. When outputting mass flow, they use a fixed-density correction to convert volumetric flow to mass flow, usually calculated around a ?fixed operating pressure. This correction can cause errors in the final ?mass flow when the operating pressure (density) of the steam changes.

Field tests show that a 10 percent change in saturated steam line pressure can cause a fixed density-compensated meter to over/under-read by up ?to 25 percent.

Some multi-variable steam meters have been designed specifically to overcome these challenges because accurate steam metering is critical not only for controlling the flow of steam and regulating temperature, but also for providing a dependable means for determining loss.

Improved Inventory Management

Level meters can improve a plant’s bottom line by enabling tighter inventory management. For example, accurate measurement allows close tracking of enzymes in slurry tanks during the mash preparation process, and of chemical consumption in CIP routines. Simply put, you need to know exactly how much material you have, and how much you use.

Some level-measuring systems use hydrostatic pressure to indirectly measure from the bottom of a tank, which assumes a constant density to determine the actual surface level. However, when the temperature changes, the density of the medium changes causing a shift in pressure, even though tank levels haven’t changed. Pressurized tanks need more compensation. An alternative approach is to use a non-contact radar or guided radar-level devices to directly detect level from the top of a tank by measuring distance, which is unaffected by pressure changes, vapors or tank pressure. Top-of-tank placement also eases repair or replacement. Bottom-of-tank implementations can only be serviced with an empty tank.

Ethanol production holds great promise for our country’s energy future. Investments in plant infrastructure today can yield benefits for years to come. As more and more plants come online, competition naturally increases. As the market matures, it will demand the highest quality at the lowest price. In this economical environment, producers will maintain profitability only by controlling production costs, reducing waste and conserving energy wherever possible. Investing in plant measurement systems, during either new construction or retrofit, has proven to offer high returns in the form of increased productivity and lower costs.
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